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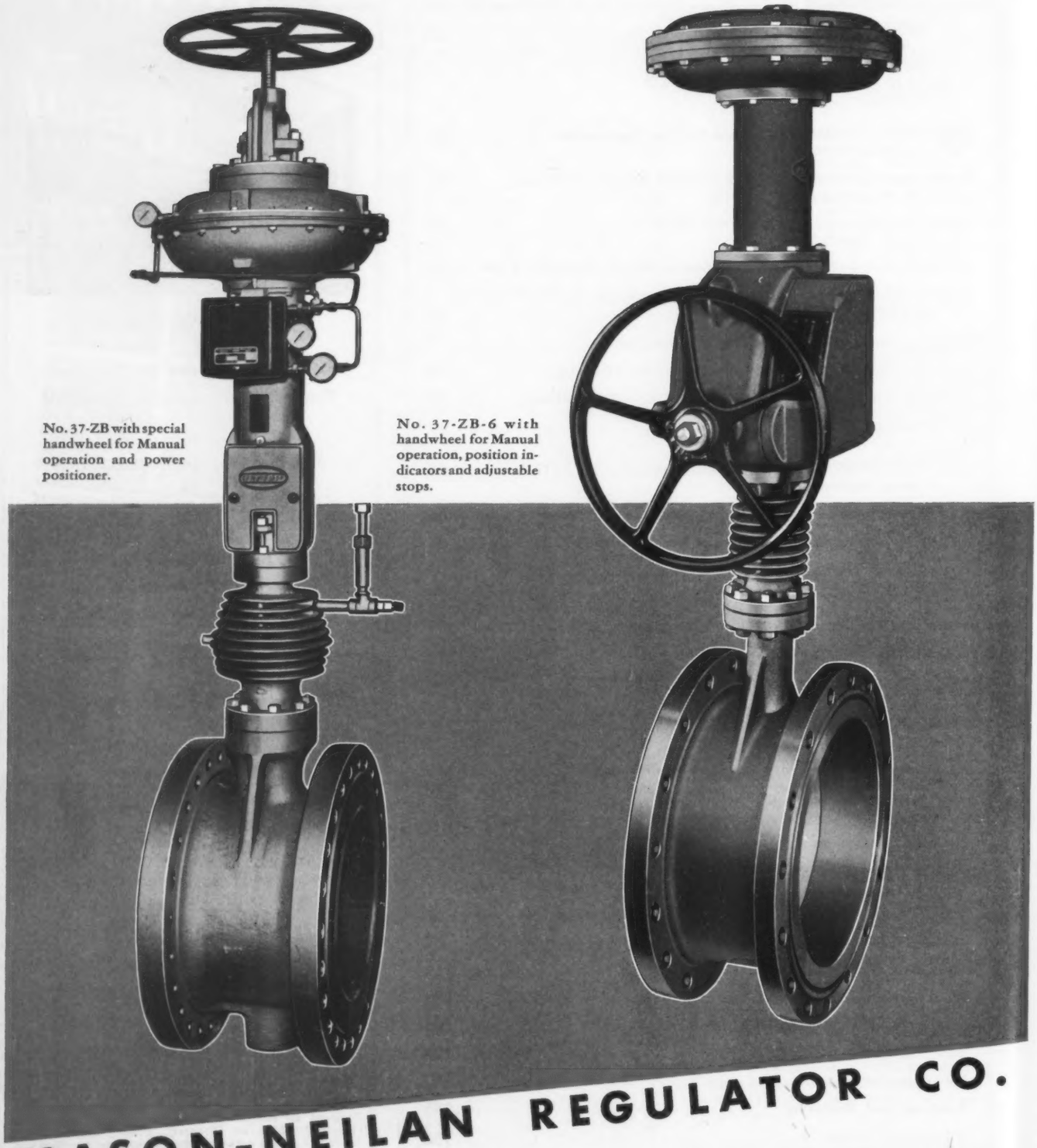

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VOLUME 20, NO. 4 APRIL, 1941

REFINER
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The Look Box

THREATS of federal control for the petroleum industry are too numerous to be taken lightly. What effect they will have is beyond answer. The industry can answer one charge, which is the core of each proposal. Either stated or implied in each is the promise of handling the petroleum industry to better advantage for the public.

Control Feeds on Industrial Bickering

The industry itself has done this job for the public. It has met an ever-increasing consumption while it has built up ever-increasing reserves, provided better and better merchandise and sold it for ever-and-ever-decreasing prices. Thus, it has supplied and continues to supply the public with what it needs at lower costs. This record refutes the charge that the industry has failed to give the public advantage of technological development.

On this stand the industry should unite. Faults it has, bickering it has, mistakes it has made. With these it has made progress and the customer has benefitted by the progress. Also it has served as the most lucrative tax-gathering industry in the world.

To some extent the industry is responsible for the threats of public control. Its several divisions and elements have snarled at each other so much that politicians have been led to the scene of battle. From the outside the petroleum industry looks like an industry that needs control.

Independent marketers, finding profit more difficult to gain, seek to have pipe lines segregated from refineries. Some producers, having wells in a state which imposes proration, learn about producers in another state which has no proration. Immediately there is a cry for proration in that state. The plea is in the name of conservation but the disgruntled producers simply suppose that the unprorated areas are allowing someone to make a profit. Recently recycling plants have been added to petroleum activity. The supposition is that they are profitable, consequently there is a demand that recycling be put under legal restrictions.

These are but a few of the wrangles which politicians can magnify into evidence in support of control, either federal or state. Industrial dissension is a fertile field for the vote seeker with social-gain pleading. So long as the petroleum industry provides it, the preachers of control will have their sermons prepared gratis.

The industry can do itself a benefit by ceasing to accuse and stand on its record of providing what the nation needs for either peace or war or both.

THE following analysis of wage rates for common labor was prepared by the American Petroleum Institute:

"Highest average hourly entrance pay rate for common laborers in any of 16 manufacturing industries surveyed is found in petroleum refining, it is reported in the United States Department of Labor's "Monthly Labor Review." The average for petroleum refining, 63.6 cents an hour, was 13.8 cents above the 16-industry average of 49.8 cents an hour.

Refinery Labor Gets High Wage

"The report, dated July, 1940, indicates that petroleum refining led not only the general average but in every section studied. Within the northern and western region, where the average was 56 cents an hour, petroleum refining averaged

67.4 cents. In the south and southwestern region, where the average was 35.5 cents an hour, petroleum refining averaged 57.9 cents an hour.

"A survey of 20 industries revealed that in the northern and western region the petroleum refining industry stood alone in paying virtually all common laborers 40 cents or more per hour. In the south and southwestern region petroleum refining had the highest concentration in the upper brackets, more than 98 percent of common laborers receiving entrance pay of 40 cents or more per hour."

Fast Finish From A Slow Start

TWO bits of news, given in more detail in other pages of this issue, seem incredible in the light of the extent to which refining has adopted chemistry and technology.

Recently the first still for refining crude oil was put in the museum of Pennsylvania State College. The news item contained this about Samuel M. Kier: "He had a chemist analyze it." Kier had come upon oil seepage near Tarentum, Pennsylvania, and believed it to be similar to a product sold for medicinal purposes, consequently his visit to a chemist.

Thus the record shows that a chemist had contact with crude oil a few years before Kier designed his still, by which he later refined crude oil to get an illuminating oil.

Then there is the news about the twentieth anniversary of the Petroleum Division of the American Chemical Society, given in the news edition of Industrial and Engineering Chemistry as follows:

"January 5, 1918, Ralph R. Matthews wrote Charles L. Parsons, secretary of the society, suggesting a division devoted entirely to petroleum rather than keeping it under the Division of Industrial and Engineering Chemistry.

"Dr. Parsons responded in favor of such action but could not offer much encouragement as there did not appear to be enough members interested primarily in petroleum to carry on such a division successfully."

Three years later the division was formed with 30 charter members.

Kier called on his chemist, perhaps in 1842, but 70 years later "there did not appear to be enough members interested . . . "

Now membership in the Petroleum Division of the American Chemical Society is around 700.

In "Catalysis," Berkman, Morrell and Egloff state: "The petroleum industry employs about 5000 research workers expending about $20,000,000 each year."

Thus it would seem that chemistry had an early introduction to oil, made but little progress in 70 years, then came to full fruition in 20 years.

By Way of Salute to Natural Gasoline

THIS issue is a salute to natural gasoline. In comparison with the whole petroleum industry, natural gasoline is small. It contributes seven percent of the motor fuel produced in the United States as well as a growing volume of liquefied petroleum gases.

Its technological contributions, however, bear a relation to the whole industry far greater than do its gallons and dollars. Primarily these advancements came about through determination of natural-gasoline manufacturers to find an assured place for plant output. But these contributions have moved into other divisions of the industry, especially into refining and into gas production, gas measurement and sampling. Moreover what was learned from studies of natural gasoline brought changes in the design of automobiles. As a by-product of a by-product, liquefied petroleum gases have given the small-town home and the farm home, the lakeside cabin and the hunting lodge cooking fuel and refrigeration from one source. Industry likewise finds these gases a source of pure fuels.

As a product, natural gasoline is not new. Advancement, however, can be restricted to the growth of the Natural Gasoline Association of America. It came into existence because plants had only a raw, wild product to offer and found the market as unstable as plant output. Through activities of the association casinghead gasoline has been converted into natural gasoline and harnessed by specifications, which assure delivery of products in keeping with what the refiner or other user demands.

The association is just 20 years old. Within that time it has promulgated one of the outstanding research programs within the industry. Today it has more unsolved problems before its committees than it had as a reason for organization back in 1921. Like other phases of the petroleum industry, solution of one problem genders other problems. Consequently its research creates work faster than it can be completed.

This is but another way of describing progress. Just as natural gasoline is small by comparison, the Natural Gasoline Association of America is small by comparison with membership, for instance in the American Petroleum Institute. But the petroleum industry has no organization more progressive than NGAA.

High-Pressure Absorption In Gas Cycling Operations

LAURANCE S. REID, University of Oklahoma

THE natural-gasoline industry is the youngest of the several major branches of the petroleum industry. Since the first commercial oil-absorption plant was installed and successfully operated in 1913, the development of natural-gasoline recovery processes has progressed at a rate which has few parallels in industrial history. As in all process industries, numerous developments have resulted from operating difficulties, new operating conditions and from market demands for new and improved products.

Early Condensate Recovery Processes

At the time the basic principles of gas cycling were first conceived and practiced, in 1937, the oil-absorption process received little or no consideration as a means for recovering the gasoline fractions from high-pressure gas, for two reasons. First, gas cycling originally was based on the retrograde condensation characteristics of these reservoir fluids. Not only was it necessary to prevent or retard the retrograde condensation of the higher boiling hydrocarbons in the reservoir by maintaining its pressure by cycling the residue gas from the condensate-recovery system, but also the earlier gas-cycling projects sought to utilize these same condensation characteristics to recover the hydrocarbon liquids by simultaneous reduction of pressure and temperature to experimentally determined levels. Second, about the same time, a series of tests on commercial absorption equipment had indicated that absorption oil losses became excessive at pressures exceeding 800 pounds per square inch, and so this pressure came to be generally accepted as the "ceiling" for economical absorber operation. The successful operation of the first gas-cycling projects indicated that plant-operating pressures should range upward from 1000 pounds per square inch if reasonable compression costs were to be obtained.

Physical Properties of Reservoir Fluids

The reservoir fluids which are subject to production by means of gas cycling differ materially in chemical composition and physical properties and yet, as a group, they are distinctly different from the relatively rich gases which are usually processed in conventional gasoline plants. Generally speaking, these fluids are produced from reservoirs under pressures ranging from 1000 to more than 6000 pounds per square inch and at temperatures ranging up to more than 200° F., under which conditions they exist in a single fluid state which is commonly thought of as "gaseous" for lack of better terminology. Extensive studies of these hydrocarbon mixtures in both field and laboratory indicate that the butane and heavier content may range from 0.3 to 4 gallons per thousand cubic feet, while the molecular weight varies from 17 to approximately 25. Furthermore, each reservoir fluid exhibits condensation characteristics which are directly related to its composition and molecular weight.[12, 13] These reservoir fluids may

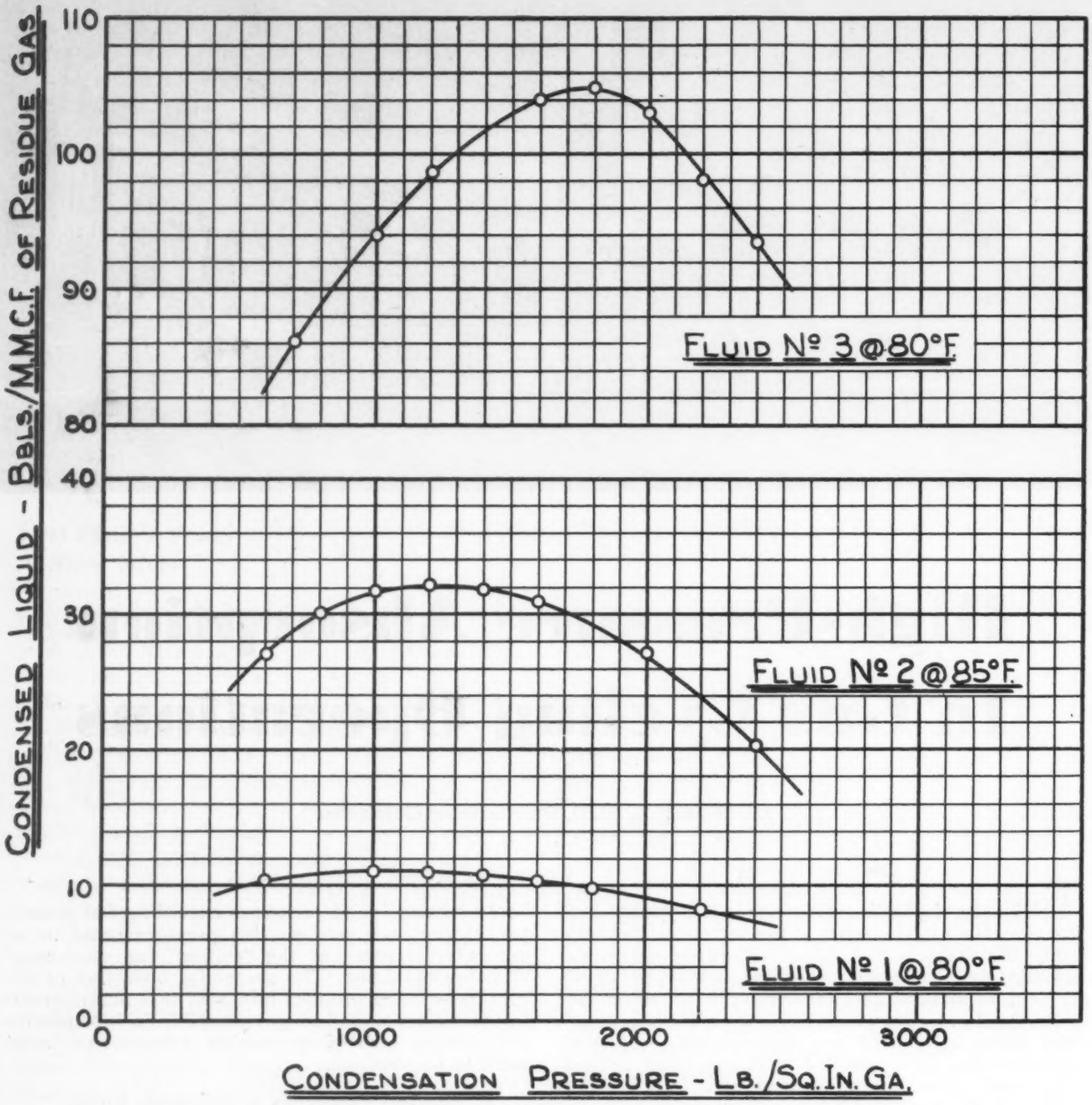


FIGURE 1

Effect of Pressure on the Condensation Characteristics of Three Typical Condensate Reservoir Fluids.

be divided into three broad classifications according to their butane and heavier content as follows:

Group No.	C_{5+} Content, GPM
1	0 to 1.0
2	1.0 to 2.0
3	Over 2.0

Fractional analyses and physical properties of three reservoir fluids which are fairly representative of these three general classifications are shown in Table 1. The condensation characteristics of the same three fluids at a temperature of 80° F. are plotted in Figure 1 for the sake of comparison.

Unfortunately, a great majority of the known condensate pools produce relatively lean gases which fall into the first classification. Nearly all of the pools which might be classified as Group 2 or 3 are being actively exploited by means of gas cycling operations.[8]

Economic Limitations of Condensation Processes

The advent of the high-pressure-absorption process into the field of gas cycling is due to certain inherent limitations of the existing condensation processes. One of the most important of these limitations is the large compression ratio often required to increase the pressure of the residue gas from the optimum condensation pressure to that pressure required to inject it into the formation from which it came. Referring to Figure 1, it is seen that the optimum condensation pressure exhibited by Fluid No. 1 is approximately 1000 pounds per square inch. If a pressure of 3000 pounds per square inch were required to return the residue gas to the formation,

TABLE 1
Physical Properties and Chemical Composition of Three Representative Reservoir Fluids

Component	Group No. 1 Mol Percent	Group No. 2 Mol Percent	Group No. 3 Mol Percent
Methane	90.15	88.88	83.94
Ethane	5.76	5.05	5.79
Propane	1.67	2.22	2.38
Iso-butane	0.59	0.29	1.01
Normal-butane	0.47	0.99	0.86
Iso-pentane	0.24	0.19	6.02*
Normal-pentane	0.19	0.33	....
Hexane and heavier	0.93	2.05	....
Total	100.00	100.00	100.00
Molecular Weight	18.9	20.3	24.2
G. P. M.—C_4+	0.92	1.52	3.47
G. P. M.—C_5+	0.58	1.12	2.86

* Calculated as pentane and heavier.

the resulting compression ration of 3.0 would require approximately 62 brake horsepower per million cubic feet of gas handled.[1] If, on the other hand, this same reservoir fluid could be processed at 1500 pounds per square inch, the compression ratio of 2.0 would require 38 horsepower per million cubic feet of gas. Similarly, by processing at 2000 pounds per square inch, the compression ratio of 1.5 would require 23 horsepower per million cubic feet of gas handled by the compressor. It is obvious that a high degree of flexibility in the adjustment of operating pressures would be of great value in the design of condensate recovery processes for gas cycling projects. However, the condensation characteristics of the reservoir fluids shown in Figure 1 indicate that substantial loss of production will occur if the recovery process is operated at a pressure which is at too great a variance with the optimum pressure characteristics exhibited by the specific hydrocarbon mixture.

Correlation of experimental data obtained in the field indicates that there is little, if any, relationship between reservoir pressure and the condensate content of the reservoir fluid. It is true that the solubility of the higher-boiling hydrocarbons in the so-called gaseous phase is directly proportional to the pressure and temperature of the reservoir and, accordingly, the mixtures classified under Groups 2 and 3 are found to exist under reservoir pressures ranging from 3500 to 5000 pounds per square inch. However, the converse is not necessarily true; i. e., the leaner mixtures of Group 1 do not always exist at proportionately lower reservoir pressures. As a mat-

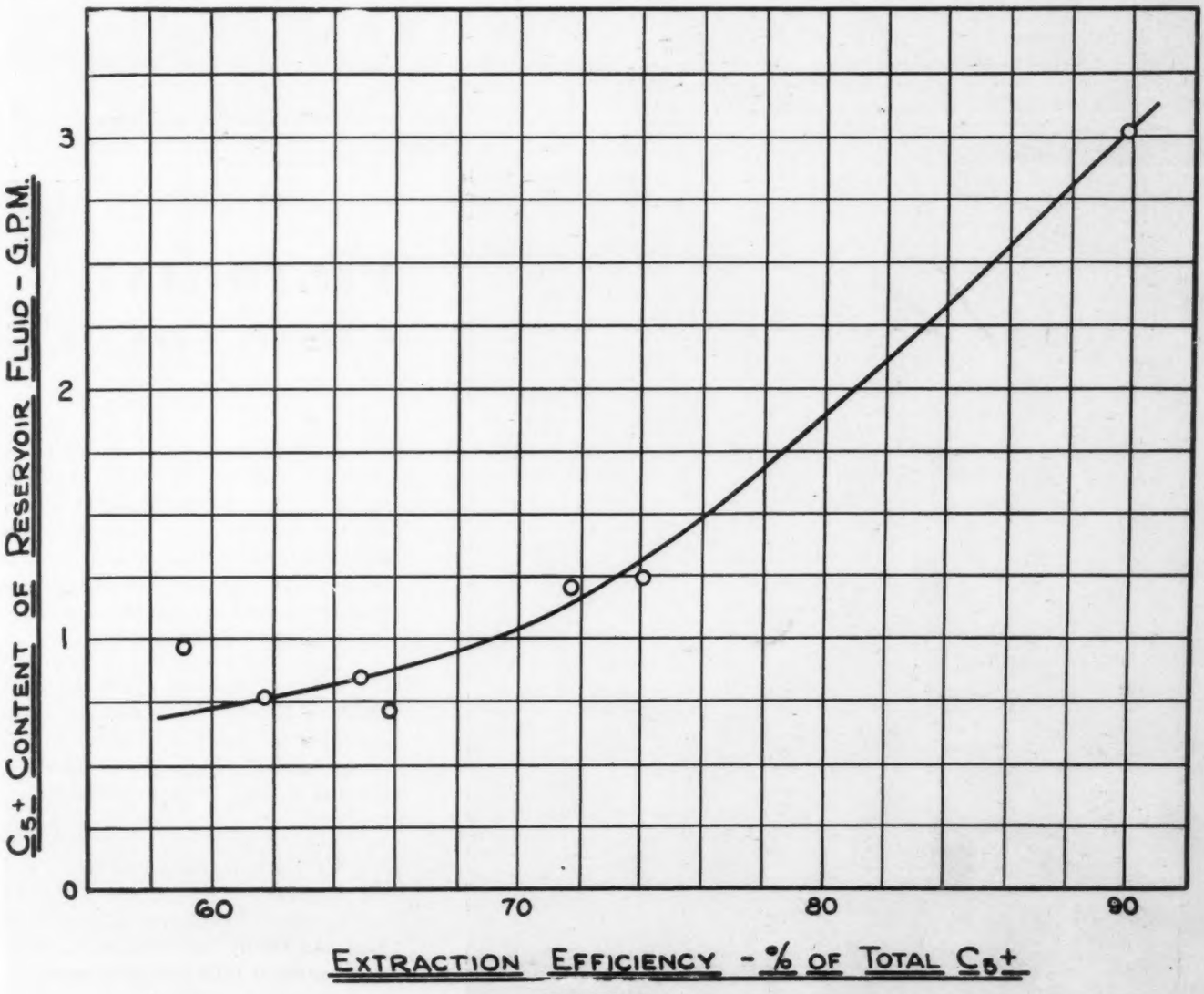
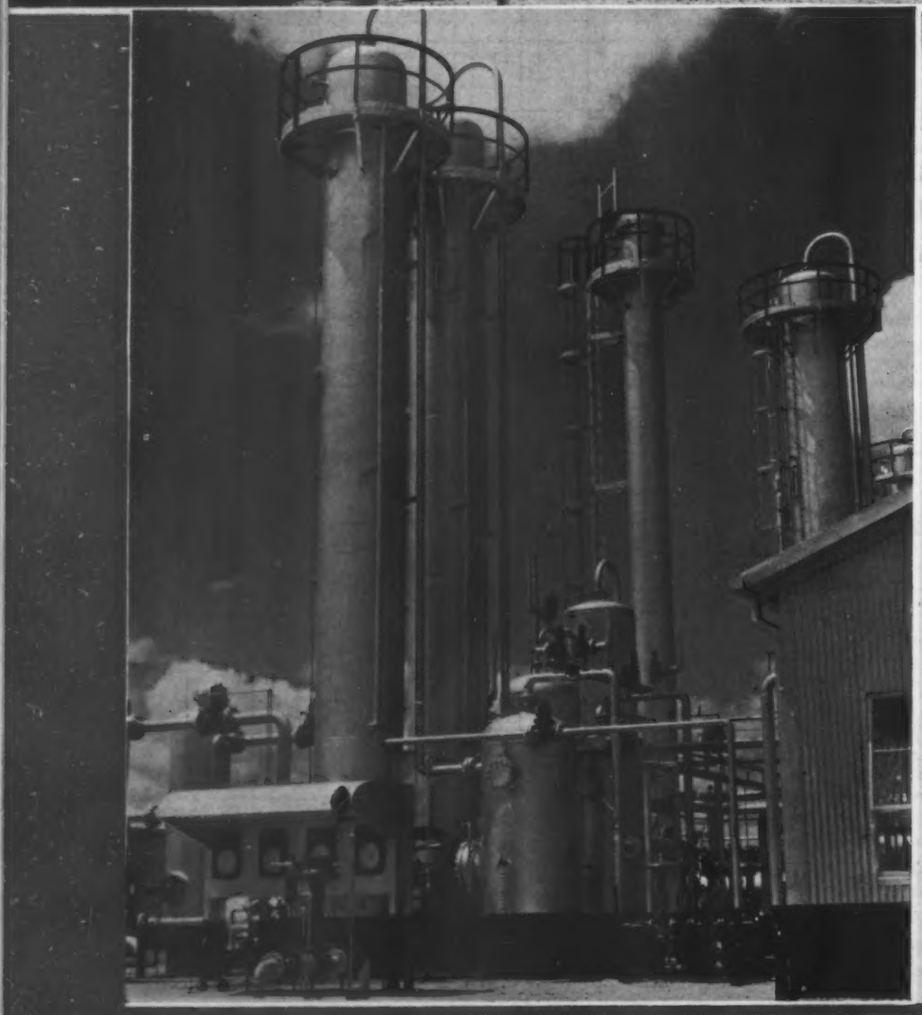


FIGURE 2
Extraction Efficiency of Condensation Processes Operating at 80° F. and Optimum Pressure versus Pentane and Heavier Content of Reservoir Fluid.



PICTORIAL CHRONOLOGY

FIRST adaptation of absorption in condensate production was at Pledger, January, 1934, by Danciger Oil & Refineries, Inc. (above). Equipment was designed for 800 pounds and operates between 720 and 750 pounds. Another view of this plant is at the top of page 55.

NEXT was the Tomball plant (left) of Humble Oil & Refining Company, put in operation in August, 1937. It was built for 900 pounds pressure and operates between 800 and 825 pounds.

ON THE opposite page is a view of the absorber columns at the Grapeland cycling plant of Lone Star Gasoline Company and Trinity Gas Corporation, which is operating at 1700 pounds pressure.

COURTESY, WYATT METAL & BOILER WORKS

ter of fact, a number of cases have been found where these leaner gases were produced from reservoirs whose pressures ranged from 4000 to more than 5000 pounds per square inch.* Although the ratio of injection pressure to the optimum condensation pressure has proved to be sufficiently favorable to justify the installation of condensation processes in a number of fields, in many instances this ratio has proved to be so great that the use of a condensation process is inadvisable from an economic standpoint. While determination of the maximum allowable compression ratio would depend on the economics of each particular case, it should be noted that this ratio does not exceed 2.5 in any of the cycling projects operating at the present time and minimum compressor requirements result from a compression ratio of approximately 1.5.[15]

A second important limitation of condensation processes is the relatively low extraction efficiencies obtained even when operating under optimum pressure conditions. Extraction efficiency may be expressed by the equation:

$$\text{Percent Extraction Efficiency} = \frac{V_r - V_g}{V_r} \times 100$$

where V_r = total volume of desirable hydrocarbons in the reservoir fluid expressed in gallons per thousand cubic feet, and

V_g = total volume of desirable hydrocarbons remaining in the residue gas after processing, expressed in gallons per thousand cubic feet of reservoir fluid processed.

This relationship applies only to the liquid which is extracted from the reservoir fluid either by absorption or by condensation and is thus made available for stabilization and processing to finished products.

All condensation processes employ the principle of simultaneous cooling and pressure reduction to predetermined conditions in order to take full advantage of the retrograde condensation [5,6,21,16] characteristics of these hydrocarbon mixtures. Low temperatures are essential to the success of these processes [2] and it is primarily in the method for and degree of cooling that the three types of condensation processes [11,14,19] differ. The simplest process operates at temperatures just above the freezing point of gas hydrates [4] so that the operating temperature usually ranges from 65 to 75° F. The other two processes employ dehydration of the incoming gas which is then cooled to approximately 20 to 40° F. by indirect ammonia refrigeration in one case, and to approximately 0° F. by direct ammonia expansion in the other. A study of extraction efficiencies obtained by portable test equipment from several different reservoir fluids indicated that the pentane and heavier content of the residue gas was very close to 0.3 gallons per thousand cubic feet, when the condensing zone was maintained at a constant temperature of 80° F. and the optimum condensation pressure exhibited by each of the various reservoir fluids. The consistency of the residue gas content, despite the variations in composition and optimum condensation pressure conditions, accounts for the shape of the curve shown in Figure 2, where the total pentane and heavier content of the reservoir fluid is plotted versus the extraction efficiency of a condensation process operating at 80° F. and optimum pressure conditions. Under these conditions, it is seen that the extraction efficiencies obtainable from fluids in Groups 1, 2, and 3 would range from approximately 40 to 70, 70 to 85, and 85 to 91 per cent, respectively. This performance has been greatly improved by the low-temperature-condensation processes, one of which has succeeded in reducing the pentane and heavier content of the residue gas to approximately 0.1 gallon per thousand cubic feet when operating at pressures exceeding the optimum condensation pressure by 300 pounds per square inch.[7] Since the pentane and heavier content of the reservoir fluid was approximately 1.0 gallon per thousand cubic feet, this figure represents an extraction efficiency of 90 per cent.

*If a market for residue gas exists, the pressure on these reservoirs could be allowed to decline, substantially, before cycling would need to be instituted to prevent condensation of hydrocarbon liquids in the reservoir.

Dilution of Reservoir Fluids by Dry Gas

Laboratory investigations[3,5,18] and field studies[8] of the displacement of reservoir fluids by dry residue gas injected into condensate reservoirs indicate that a single cycle of residue gas will result in the production of from 50 to 60 percent of the original reservoir fluid. In other words, if a condensate pool were properly drilled and produce by cycling operations, from 50 to 60 percent of the original reservoir fluid would have been produced and processed by the time the residue gas breaks through into the producing wells and dilutes the rich gas. Cycling operations cannot continue long after this dilution sets in and new producing wells must be drilled or the project must be shut down and abandoned. It is imperative, therefore, to make every effort to secure maximum condensate recovery at minimum cost and, to this end, the oil absorption process has been adapted to gas cycling operations.

Counter-flow Absorption Process

The first high-pressure-absorption process to be used for gas cycling was completed and placed in operation in the Agua Dulce field, near Corpus Christi, Texas, in January, 1939.[12] Designed to process 60,000,000 cubic feet of gas per day at an absorber pressure of 1200 pounds per square inch, this installation proved to be so completely successful that relatively few basic changes and improvements have been made in the 12 or more plants of this type which have been built within the past two years. This process employs counter-current contact of the rich gas by specially processed absorption oil in vertical bubble tray columns of more or less conventional design. Usually two or more absorbers are used in parallel, in order to provide adequate capacity, so that the residue gas discharged from each column passes directly to the suction of the compressors with a minimum pressure drop. Recovery of gasoline from the rich-oil-flash-tank vapors and raw-gasoline-make-tank vapors is often effected by use of a low-pressure absorber which circulates the same oil used in the high-pressure absorbers. The remainder of the system follows along the lines of conventional gasoline-plant design, according to the flow diagram shown in Figure 3. One important improvement which has been made in the more recent installations provides inlet-gas scrubbers which are set ahead of the high-pressure absorbers in order to remove all condensate and traces of free water and drilling mud which are often carried into the recovery system along with the inlet gas. After removal from the gas stream, these liquids are passed to a flash separator which is maintained at

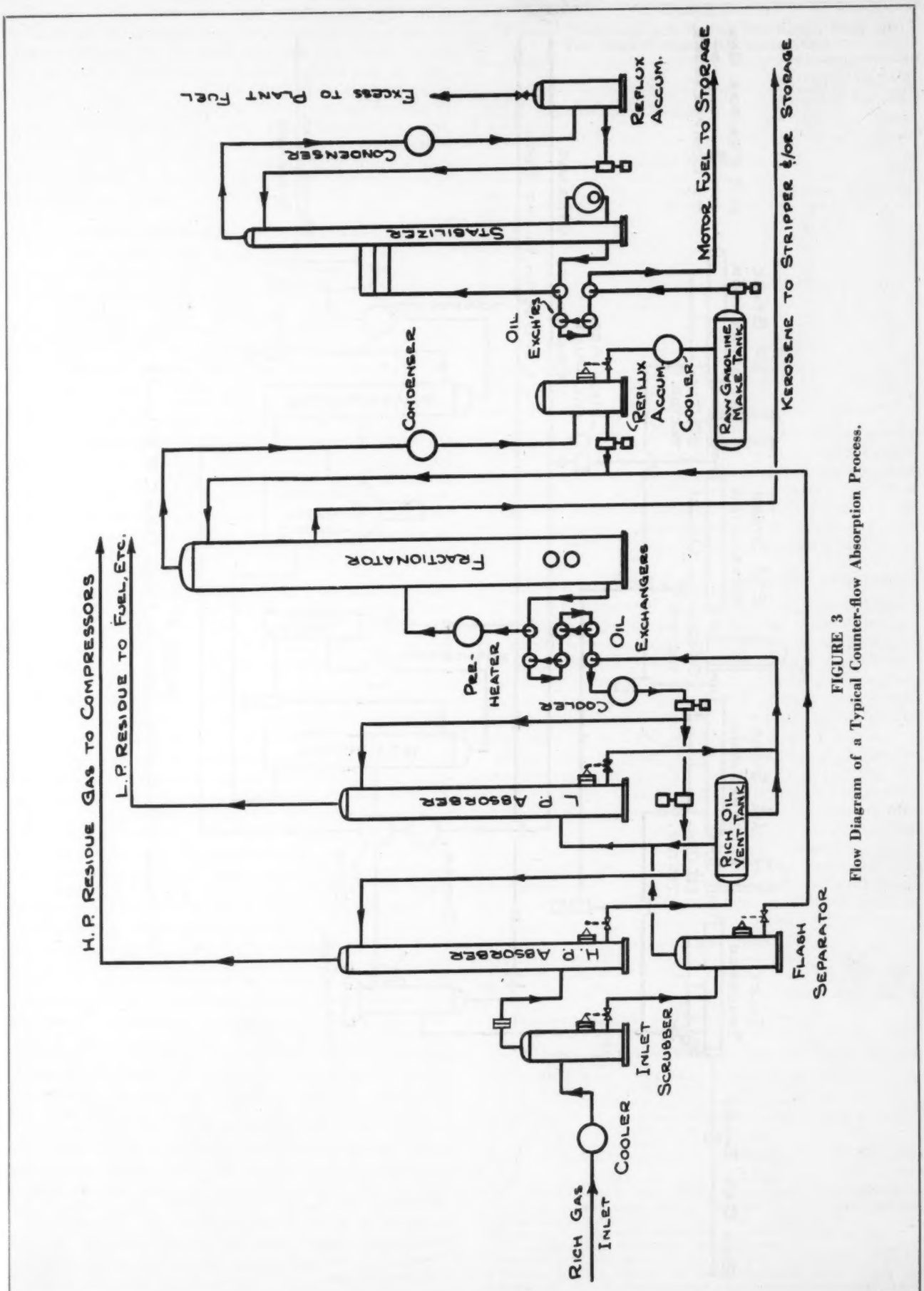


FIGURE 3
Flow Diagram of a Typical Counter-flow Absorption Process.

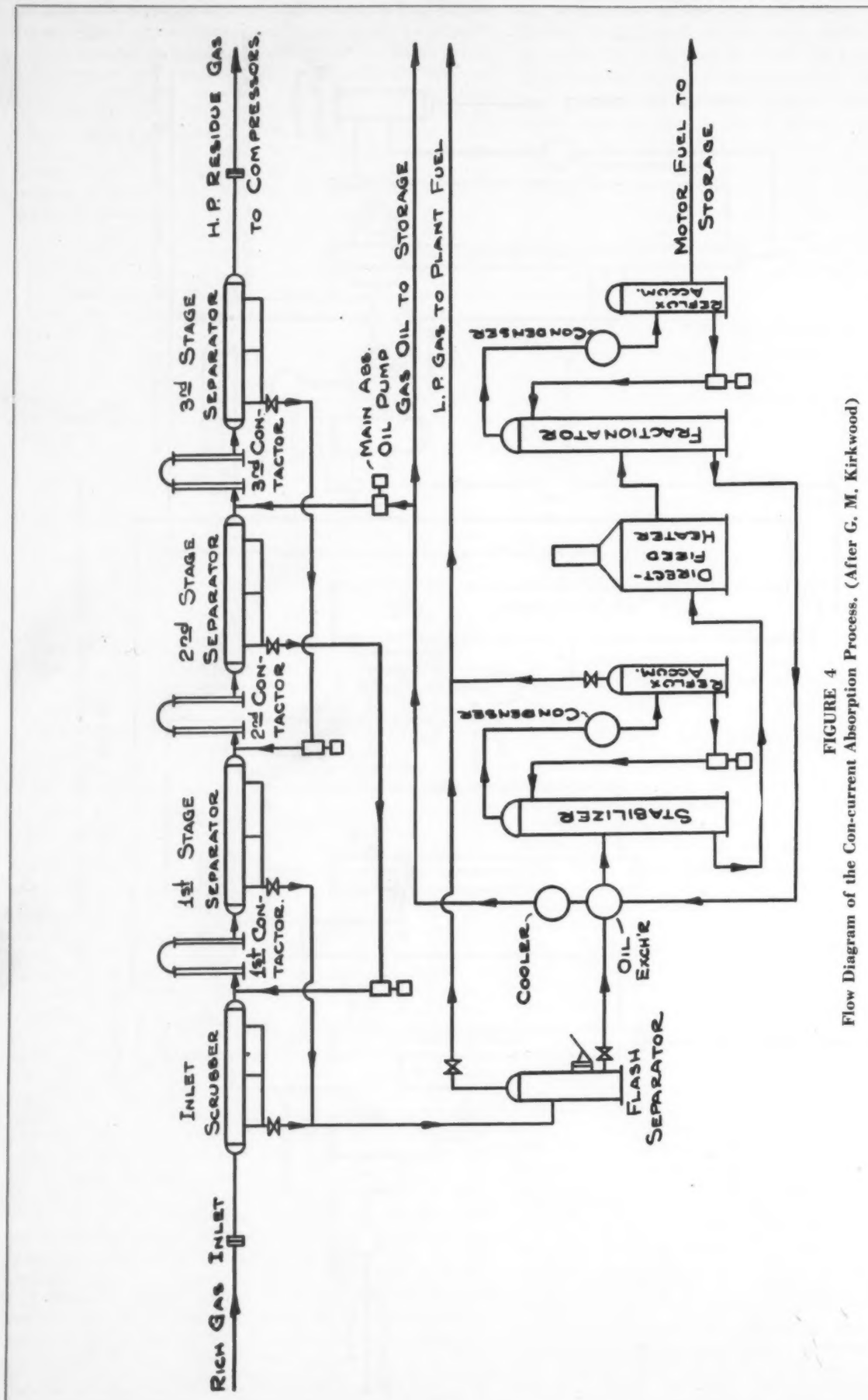


FIGURE 4
Flow Diagram of the Con-current Absorption Process. (After G. M. Kirkwood)

a comparatively low pressure. The water and mud is bled off, the vapors liberated from solution in the condensate by the reduced pressure are taken to the low-pressure absorber and the condensate is discharged into the top of the fractionator along with reflux from the accumulator. This practice results in greater fractionator capacity and eliminates severe disturbances in high-pressure-absorber operation caused by slugs of water and drilling mud which would otherwise be carried on into the absorbers from time to time.

Con-current Absorption Process

An interesting departure from high-pressure-absorber design has been developed recently and installed in conjunction with a gas cycling project in the Grapeland Pool, Houston County, Texas.[10] Following removal of condensate and free water, the high-pressure gas is contacted with absorption oil in three separate stages. This process is unique in the fact that the oil and gas pass through each contacting stage in con-current flow, although the lean absorption oil is introduced into the third stage, trapped off and pumped into the second stage where it is again trapped off, after the contact, and pumped to the first stage. From this point the rich oil is discharged to a conventional processing system, along with the condensate which has been trapped off by the inlet scrubber, as shown in Figure 4. As a result, it might be said that this process employs the principles of both con-current and counter-current flow. The advantages claimed for this process, over the counter-flow process described above, are greater flexibility and lower first cost due to elimination of bubble trays and a decrease in the diameter of the high-pressure vessel equipment.

Absorption Oils for High Pressure Operations

Extensive research on the behavior of hydrocarbon mixtures at elevated pressures, [6,16,20] coupled with experience gained from plant operations during the past two years, has resulted in the extension of satisfactory absorber performance from a pressure of 1200 to 1900 pounds per square inch in counter-flow absorption processes, while the con-current process is reported to operate satisfactorily at 2000 pounds per square inch. These high operating pressures are attained by adjusting the composition of the rich-gas-absorption-oil mixture to proper proportions by close control of circulation rates and the chemical and physical properties of the absorption oil. Low circulation rates have been found to prevail in the operation of high-pressure absorbers, ranging from 1 to 4 gallons per thousand standard cubic feet of gas processed, depending upon the operating pressure and temperature of the absorbers. Most naturally occurring condensates contain from 5 to 15 percent of heavy kerosene or gas oil which is processed to absorption oil specifications and used for make-up. For this reason, no two oils are alike although, in general, it may be said that the gravity of absorption oils used in high-pressure-atmospheric-temperature operations ranges from 32 to 38° A.P.I., molecular weight ranges from 200 to 275, while the boiling range usually lies within the limits of 400 to 700° F.

To illustrate the differences in these absorption oils, the physical properties and Engler distillation characteristics of two oils are presented in Table 2. Both oil samples were taken from counter-flow absorption processes operating at identical pressures in different fields. Comparatively little is known about the influence of various physical and chemical properties of these oils upon their performance characteristics, and it is believed that certain of these properties must be studied thoroughly before absorber operating pressures can be extended substantially beyond 2000 pounds per square inch.

TABLE 2
Physical Properties and Engler Distillation Data on Two High Pressure Absorption Oils

	Oil No. 1	Oil No. 2
Gravity	32.0° A.P.I.	37.3° A.P.I.
Molecular weight by benzene freezing-point depression	217	252

Engler Distillation

Percent	Temp. °F.	Temp. °F.
Initial boiling point	392	283
5	466	422
10	488	480
20	520	527
30	531	552
40	546	572
50	558	590
60	570	606
70	581	624
80	600	644
90	618	679
95	678	717
End Point	689	720
Recovery, percent	99.1	96.0
Residue, percent	0.4	3.0
Loss, percent	0.5	1.0

Extraction Efficiencies of Absorption Processes

The extraction efficiencies of absorption processes which have been placed in operation up to the present time are remarkably high. Removal of 99+ percent of the pentane and heavier content and 80 percent of the butane have been reported for absorption processes operating up to 1800 pounds per square inch [8,17] with slightly lower recoveries indicated for operations up to 2000 pounds per square inch.

Reviewing the progressive development of absorption processes in gas-cycling operations during the past two years, it is seen that the major limitations of the condensation processes have been overcome, at least to a substantial degree. High extraction efficiencies obtained at operating pressures up to 2000 pounds per square inch have extended the application of gas cycling methods to several pools which, heretofore, have not been exploited because of extremely high injection-pressure requirements.

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Production of Aviation Motor Fuel From Natural Gasoline

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FOR many years the principal use of natural gasoline in the oil industry has been to raise the volatility of motor fuel, and consequently natural gasoline customarily has been sold on a vapor pressure-volatility basis with little regard for other characteristics such as octane blending value and lead susceptibility. Lately, with the increased demand for high-octane aviation gasoline and with the depressed market for natural gasoline, many plants in the southwest are considering the manufacture of aviation base stocks as a means of making a larger profit on their production.

This article presents the results of evaluations which were made of two different natural gasolines to determine their potentialities as sources of base stocks for the manufacture of aviation motor fuel. It was found that one of them contained appreciable quantities of a good base material while the other was unsuitable for this purpose. This difference illustrates the danger inherent in failing to get accurate information as to the character of each stock it is desired to process. Thus, from a study of the results of the first evaluation it might have been erroneously concluded that a suitable quality aviation fuel can be made from any natural gasoline by the method used.

While there are a number of ways in which aviation motor fuel (meeting the United States Army-Navy specifications[1]) can be made from natural gasoline, it was decided to use a relatively simple method. Also, it was decided to restrict the work to the production of the 91-octane grade[1] with the thought that this would simplify the study and still give significant results. The procedure consisted of debutanization, dependentanization of the butane-free bottoms, since this butane-free material had too high a vapor pressure and was too light to meet the aviation distillation specifications, and then fortification of the dependentanized material (with iso-pentane) to meet the requirement of 7-pound Reid vapor pressure. Iso-pentane was used as the blending agent since in this way the clear octane number of the blend was made higher than if a mixture of normal and iso-pentane had been used. (Iso-pentane's octane rating is about 92, while that of normal pentane is about 60.) Though other blending agents such as alkylate, iso-octane, neo-hexane, or any combination of these could have been used, they are not contained in the charge stock, as is the iso-pentane, and in addition to being less readily available would be more expensive. At any rate, it is felt that the method used has the advantage of simplicity and gives results that are indicative of the ease or difficulty with which aviation gasoline can be made from the stock processed.

The first natural gasoline studied was a 26-pound vapor-pressure material from the East Texas field. In the processing of this gasoline, the initial step was to completely debutanize it and determine the yield and characteristics of the debutanized liquid. This operation was carried out in the glass stabilizer shown in Figure 1.

Table 1 gives the yields of butane and debutanized bottoms realized in this operation, together with inspections of these products. Although it was not feasible to weigh the charge stock, because of its high butane content, the total volume of the products recovered checked the volume of the sample container, showing that no appreciable loss was encountered.

As pointed out before, the debutanized material had too high a vapor pressure and was too light to meet the aviation distillation specifications, and had to be dependentanized. This was done on the true-boiling-point still shown in Figure 2. On this still there is a means for varying the reflux ratio, thus permitting control of the efficiency of the fractionation. (The apparatus at the right is for atmospheric distillations while the one on the left is for vacuum operations). To insure that no pentane would be lost, a trap was maintained at 0° F. to condense and return to the product receiver any pentane that might have evaporated. Then, the pentanes were analyzed in the Podbielniak column, shown in the right of Figure 3, to determine the relative amounts of the iso and normal compounds. Table 2 gives the yields and inspections of the products from the dependentanization operation.

Relatively little extra equipment would be required for an existing natural gasoline plant to remove the iso-pentane from the heavier material. A fractionating tower having about 50 trays, together with the usual auxiliary equipment such as a reboiler, reflux pump, etc., would be needed to do the job. Cooling water, steam, and electricity would also be needed, though not in large quantities.

The next step was the blending of the dependentanized liquid with iso-pentane in an attempt to produce a 7-pound Reid-vapor-pressure aviation motor fuel meeting the Army-Navy specifications. Data for the blending operation, together with a recapitulation of yields for the debutanization and dependentanization steps, are presented in Table 3.

Since the maximum amount of tetraethyl lead allowed by the Army-Navy specifications is 4.0 cc.

[1] These specifications were approved by joint action of the War and Navy departments for four grades of aviation gasoline (65-, 73-, 91- and 100-octane numbers) and were put into effect early in 1941. Among the specifications are:

Octane number—C.F.R. Aviation knock test method (Min.)	65	73	91	100
T.E.L. content—c.c./gal. (Max)	—	1.0	4.0	3.0
Reid Vapor Pressure—lbs./sq.in(Max.)	7.0	7.0	7.0	7.0
Distillation				
At 10% Evap., max. temp. of	167°F.	167°F.	167°F.	167°F.
At 50% Evap., max. temp. of	221°F.	221°F.	212°F.	212°F.
At 90% Evap., max. temp. of	302°F.	302°F.	275°F.	275°F.
10% Evap. + 50% Evap., min. of	307°F.	307°F.	307°F.	307°F.
Residue—% (Max.)	1.5	1.5	1.5	1.5
Loss—% (Max.)	1.5	1.5	1.5	1.5
Sulfur—Wt. % (Max.)	0.05	0.05	0.05	0.05

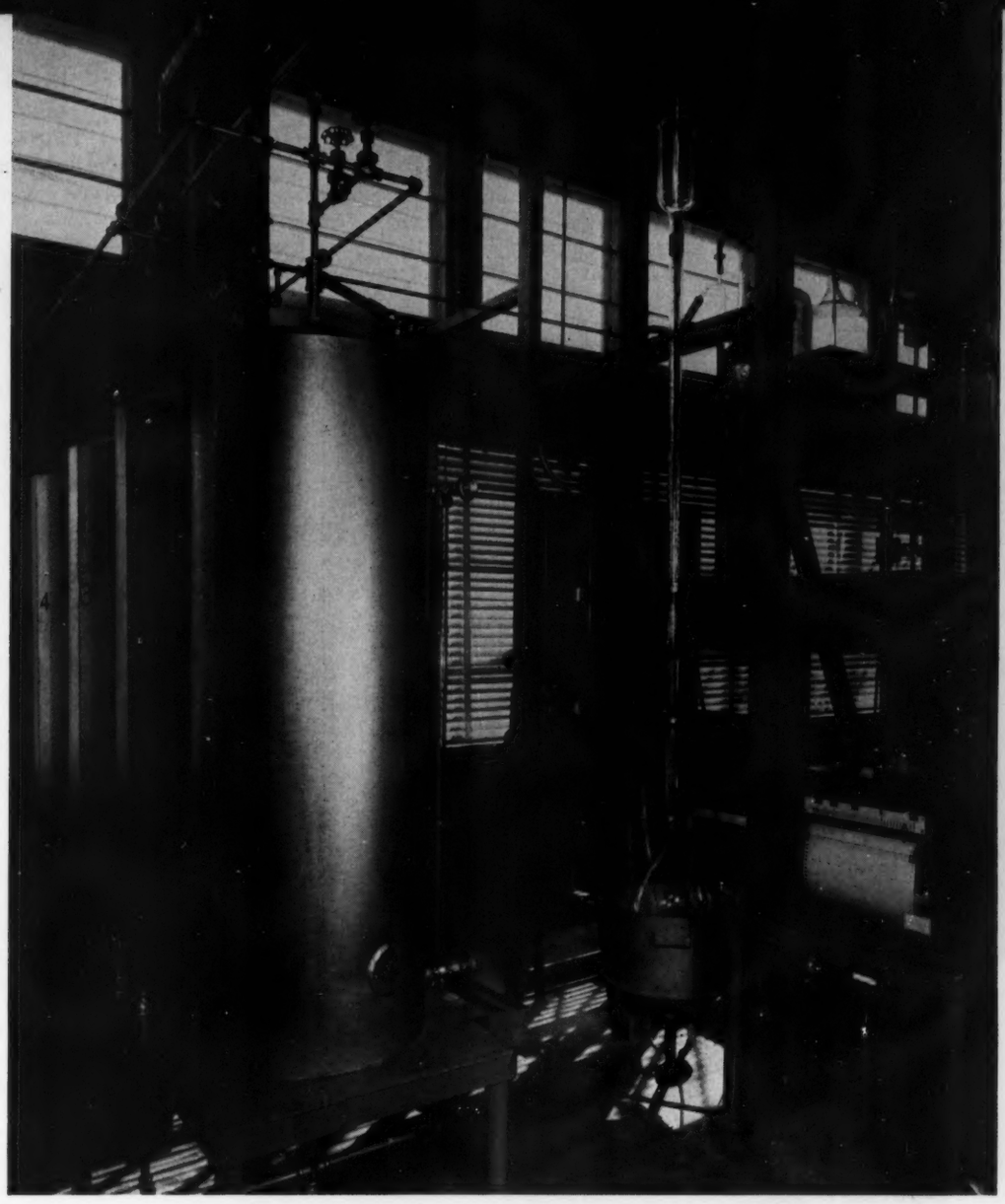


FIGURE 1

Laboratory glass stabilizer

TABLE 1

Evaluation of 26-Pound East Texas Natural Gasoline—Debutanization Operation

(1) Yields Based on 26 lb. Natural Gasoline	Volume Percent	Weight Percent
Input:		
26-pound gasoline	100.0	100.0
Output:		
Butane	33.6	30.6
Debutanized bottoms	66.4	69.4
Total	100.0	100.0

(2) Inspections of Products:	
(a) Butane: Gaseous Specific Gravity = 1.985 (Air = 1.000)	
(b) Debutanized Bottoms:	
Specific Gravity @ 60° F	0.6631
Gravity—°A.P.I. @ 60° F	81.9
A.S.T.M. Distillation:	
I.B.P.—°F	95
5 percent	103
10 percent	106
20 percent	109
30 percent	113
40 percent	117
50 percent	123
60 percent	129
70 percent	141
80 percent	161
90 percent	198
95 percent	234
E. P.	300
Percent Recovery	97.0
Percent Residue	0.6
Percent Loss	2.4
Reid Vapor Pressure—lbs./sq. in.	13.2
Octane—C.F.R.-M (Clear)	71.6

TABLE 2

Evaluation of 26-Pound East Texas Natural Gasoline—Depentanization Operation

(1) Yields Based on Debutanized Bottoms	Vol. Percent	Wt. Percent
Input:		
Debutanized Bottoms	100.0	100.0
Output:		
Iso-pentane	25.9	24.2
Normal Pentane	31.0	29.8
Depentanized Bottoms	43.1	46.0
Total	100.0	100.0
Weight Balance—percent	99.9	

(2) Inspections	Total Pentanes	Depentanized Bottoms
Specific Gravity @ 60° F	0.6303	0.7064
Gravity—°A.P.I. @ 60° F	93.0	68.8
A.S.T.M. Distillation:		
I.B.P.—°F	84	134
5 percent	87	149
10 percent	90	153
20 percent	93	157
30 percent	95	162
40 percent	97	167
50 percent	99	172
60 percent	102	178
70 percent	103	186
80 percent	104	200
90 percent	108	226
95 percent	112	256
E. P.	.....	332
Percent Recovery	96.0	99.0
Percent Residue	0.0	1.0
Percent Loss	4.0	0.0
Reid Vapor Pressure—lbs./sq. in.	17.5	5.2
Octane—C.F.R.-M (Clear)	74.5	67.9

per gallon (for the 91-octane grade), it was necessary to plot the lead response of the gasoline blend to estimate the octane number for this concentration of anti-knock fluid. This plot, shown in Figure 4, has been made on the ethyl blending chart of Hebl, Rendel, and Garton.[2] (The coordinates have been set up in such a manner that lead response plots as a straight line if the experimental determinations are completely accurate.) Reading from Figure 4 at 4.0 cc. of tetraethyl lead per gallon, it is seen that the C.F.R.M. octane number of the blend is 90, which is equivalent to about 91-92 by the C.F.R. aviation knock-test method.

Since the blended gasoline had a sufficiently high anti-knock rating to meet the requirement of 91-octane number (C.F.R.-A.F.D. method) and since the distillation range and other tests met the Army-Navy specifications, it can safely be said that East Texas casinghead furnishes a promising source of good aviation gasoline base stocks. Thus, by a relatively simple procedure it has been found possible to make 32.0 percent of (91-octane) aviation motor fuel from the natural gasoline. At the same time, 17.2 percent iso-pentane was produced above that amount required to make the aircraft fuel.

[2] Oil and Gas Journal, September 8, 1938.

TABLE 3
Evaluation of 26-Pound East Texas Natural Gasoline—Blending Operation and Recapitulation of Yields

(1) Blending Operation	Vol. Percent	Vol. Percent (Based on Nat. Gaso.)
Iso-pentane (commercial)	10.7	3.4
Depentanized Bottoms	89.3	28.6
Total	100.0	32.0

(2) Recapitulation of Yields Based on 26 Lb. Natural Gasoline	Vol. Percent	Wt. Percent
Butanes	33.6	30.6
Normal Pentane	17.2	16.8
Iso-pentane	20.6	20.7
Depentanized Bottoms	28.6	31.9
Total	100.0	100.0

(3) Inspections	Blended Aviation Gasoline	Debutanized Bottoms	Depentanized Bottoms
Specific Gravity @ 60° F	0.6964	0.6631	0.7064
Gravity—°A.P.I. @ 60° F	71.7	81.9	68.8
A.S.T.M. Distillation:			
I.B.P.—°F	122	95	134
5 percent	137	103	149
10 percent	142	106	153
20 percent	146	109	157
30 percent	151	113	162
40 percent	158	117	167
50 percent	168	123	172
60 percent	174	129	178
70 percent	183	141	186
80 percent	197	161	200
90 percent	227	198	226
95 percent	258	234	256
E. P.	325	300	332
Percent Recovery	98.0	97.0	99.0
Percent Residue	1.0	0.6	1.0
Percent Loss	1.0	2.4	0.0
Percent Recovery @ 167° F	51.5	82.5	38.0
Percent Recovery @ 212° F	86.0	92.5	85.5
Reid Vapor Pressure—lbs./sq. in.	7.1	13.2	5.2
Gum (A.S.T.M.)—mg./100 c.c.	2	....	....
Acid Heat (A.S.T.M.)—°F	3	....	....
Sulfur—Weight percent	0.002	....	....
Color—Saybolt	+30	....	....
Doctor Test	Neg.	....	....
Corrosion—Copper Strip @ 212° F.	Pass	....	....
Octane—C.F.R.-M (Clear)	70.4	71.6	67.9
Octane—C.F.R.-M. (1 c.c. T.E.L.)	83.2	....	....
Octane—C.F.R.-M. (3 c.c. T.E.L.)	87.4	....	....
Octane—C.F.R.-M. (6 c.c. T.E.L.)	92.4	....	....
Octane—C.F.R.-M. (4 c.c. T.E.L.) Est.	90	....	....
Octane—C.F.R.-A.F.D. (4 c.c. T.E.L.) Est	91–92	....	....

TABLE 4
Inspections of 18-Pound Natural Gasoline

Specific Gravity @ 60° F	0.6643
Gravity—°A.P.I. @ 60° F	81.5
A.S.T.M. Distillation:	
I. B. P.—°F	85
5 percent	90
10 percent	96
20 percent	105
30 percent	114
40 percent	127
50 percent	140
60 percent	156
70 percent	176
80 percent	200
90 percent	238
95 percent	270
E. P.	291
Percent Recovery	97.0
Percent Residue	0.6
Percent Loss	2.4
Reid Vapor Pressure—lbs./sq. in.	17.5
Octane—C.F.R.-M. (Clear)	66.9

Another natural gasoline, from a different field, has also been investigated as a potential source of aviation gasoline. This material was an 18-pound-vapor-pressure natural, for which inspections are given in Table 4. The procedure followed was the same as that outlined in the preceding paragraphs for the evaluation of the East Texas stock. Data for the debutanization, depentanization, and blending operations are shown as Table 5, 6, and 7.

The blended gasoline made from the 18-pound material did not have a high enough octane rating to meet the Army-Navy specification of 91. Thus, it is estimated that the anti-knock rating would be only 87 by the A.S.T.M. method (about 88 by the aviation knock test method) when the blend contains 4.0 cc. of tetraethyl lead per gallon. Even though it should be possible to produce a high-test aircraft motor fuel from the 18-pound-vapor-pressure charge, large quantities of such expensive blending stocks as neo-hexane, iso-octane, or alkylate would be required, and such a procedure probably could not be justified on an economic basis. Indications are that the octane number of the base stock must be in the

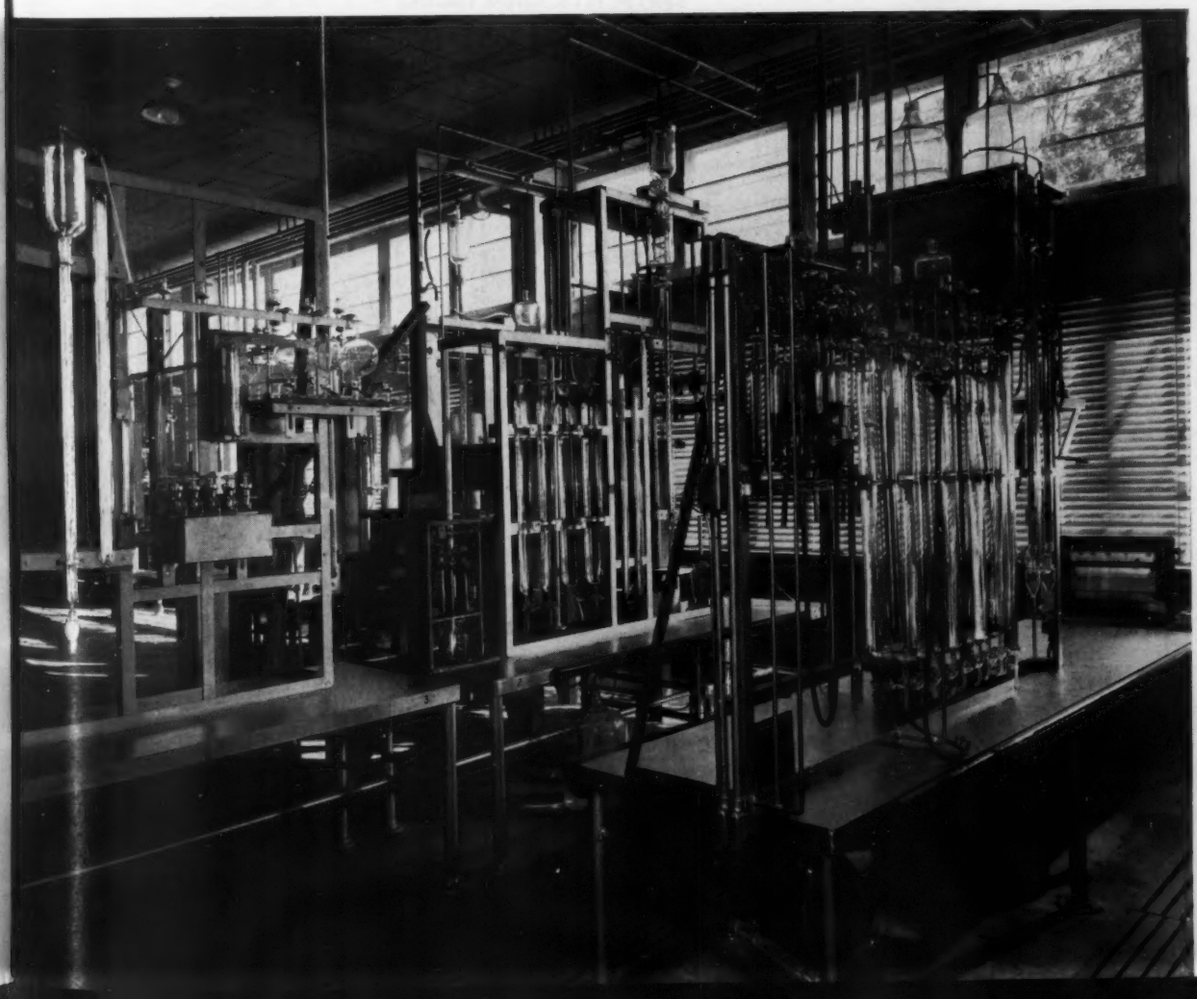
TABLE 5
Evaluation of 18-Pound Natural Gasoline—Debutanization Operation

(1) Yields Based on 18 Lb. Natural Gasoline	Volume Percent	Weight Percent
Input:		
18 Pound Gasoline	100.0	100.0
Output:		
Butane	16.6	14.6
Debutanized Bottoms	83.4	85.4
Total	100.0	100.0

(2) Inspections of Products:	
(a) Butane: Gaseous Specific Gravity = 2.025 (Air — 1.000)	
(b) Debutanized Bottoms:	
Specific Gravity @ 60° F	0.6787
Gravity—°A.P.I. @ 60° F	77.0
A.S.T.M. Distillation:	
I.B.P.—°F	100
5 percent	118
10 percent	122
20 percent	128
30 percent	134
40 percent	142
50 percent	153
60 percent	165
70 percent	182
80 percent	205
90 percent	236
95 percent	260
E. P.	295
Percent Recovery	98.0
Percent Residue	0.5
Percent Loss	1.5
Reid Vapor Pressure—lbs./sq. in.	8.9
Octane—C.F.R.-M. (Clear)	60.4

FIGURE 2
True boiling point stills

FIGURE 3
Gas analysis apparatus



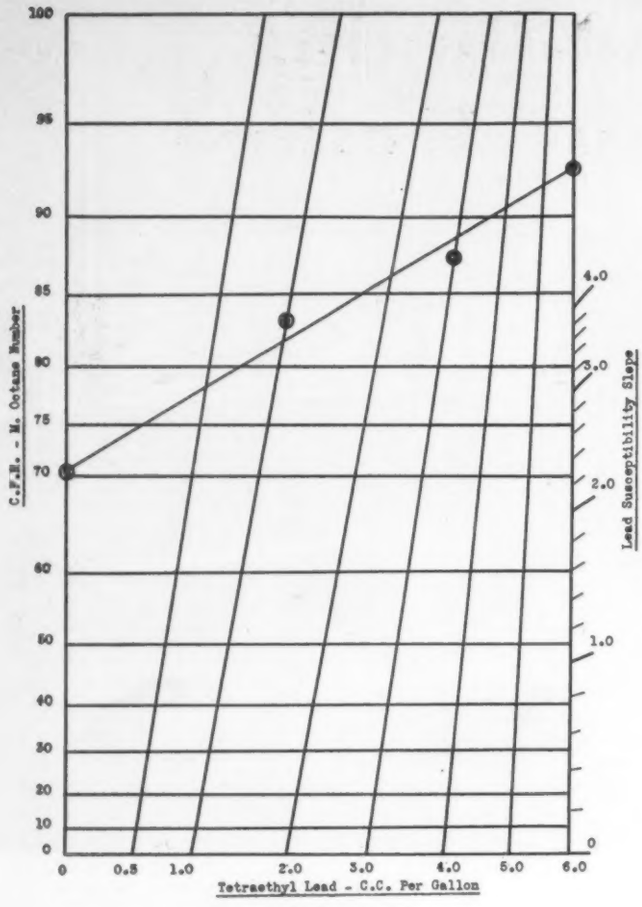


FIGURE 4

Lead response and aviation gasoline blend from East Texas natural gasoline

neighborhood of 70 before it is practical to make aviation gasoline from it.

In spite of the fact that the results of this latter program were largely of a negative nature, they are important in that they illustrate the necessity for accurately evaluating each stock it is desired to process. That is, it might have been erroneously concluded from the study of the 26-pound East Texas material that a suitable quality aviation gasoline base stock can be made from any casinghead.

In conclusion, it should be mentioned that a number of small natural gasoline manufacturers, having run evaluations of their products, have been able to command premium prices for their output because of their value as base stocks.

TABLE 6

Evaluation of 18-Pound Natural Gasoline—Dependentanization Operation

(1) Yields and Material Balance	Vol. Percent	Wt. Percent
Input:		
Debutanized Bottoms	100.0	100.0
Output:		
Iso-pentane	14.5	13.2
Normal Pentane	20.6	19.6
Dependentanized Bottoms	64.9	67.2
Total	100.0	100.0
Weight Balance—percent	99.4	

(2) Inspections	Total Pentanes	Dependentanized Bottoms
Specific Gravity @ 60° F	0.6306	0.7050
Gravity—°A.P.I. @ 60° F	92.9	69.2
A.S.T.M. Distillation:		
I.B.P.—°F	88	140
5 percent	90	162
10 percent	91	166
20 percent	92	169
30 percent	93	173
40 percent	94	178
50 percent	96	186
60 percent	98	194
70 percent	100	209
80 percent	102	225
90 percent	106	251
95 percent	109	277
E. P.	.....	300
Percent Recovery	98.0	97.0
Percent Residue	0.2	0.6
Percent Loss	1.8	2.4
Reid Vapor Pressure—lbs./sq. in	17.2	4.2
Octane—C.F.R.-M (Clear)	73.2	53.5

TABLE 7

Evaluation of 18-Pound Natural Gasoline—Blending Operation and Recapitulation of Yields

(1) Blending Operation	Vol. Percent	Vol. Percent (Based on Nat. Gaso.)
Iso-pentane (commercial)	17.5	11.5
Dependentanized Bottoms	82.5	54.1
Total	100.0	65.6

(2) Recapitulation of Yields Based on 18 Lb. Natural Gasoline	Vol. Percent	Wt. Percent
Butanes	16.6	14.6
Iso-pentane	12.1	11.3
Normal Pentane	17.2	16.7
Dependentanized Bottoms	54.1	57.4
Total	100.0	100.0

(3) Inspections	Blended Aviation Gasoline	Debutanized Bottoms	Dependentanized Bottoms
Specific Gravity @ 60° F	0.6919	0.6787	0.7050
Gravity—°A.P.I. @ 60° F	73.0	77.0	69.2
A.S.T.M. Distillation:			
I.B.P.—°F	112	100	140
5 percent	134	118	162
10 percent	139	122	166
20 percent	146	128	169
30 percent	154	134	173
40 percent	164	142	178
50 percent	174	153	186
60 percent	186	165	194
70 percent	199	182	209
80 percent	218	205	225
90 percent	247	236	261
95 percent	274	260	277
E. P.	304	295	300
Percent Recovery	97.5	98.0	97.0
Percent Residue	1.0	0.5	0.6
Percent Loss	1.5	1.5	2.4
Percent Recovery @ 167° F	42.9	61.5	12.0
Percent Recovery @ 212° F	78.5	82.5	73.0
Reid Vapor Pressure—lbs./sq. in	7.0	8.9	4.2
Gum (A.S.T.M.)-mg./100 c.c	3	....	....
Acid Heat (A.S.T.M.)—°F	4	....	....
Sulfur—Weight percent	0.004	....	....
Color—Saybolt	+30	....	....
Doctor Test	Neg.	....	....
Corrosion—Cu Strip @ 212° F	Pass	....	....
Octane—C.F.R.-M. (Clear)	60.3	60.4	53.5
Octane—C.F.R.-M. (1 c.c. T.E.L.)	75.7	....	....
Octane—C.F.R.-M. (3 c.c. T.E.L.)	83.6	....	....
Octane—C.F.R.-M. (4 c.c. T.E.L.) Est.	87	....	....
Octane—C.F.R.-A.F.D. (4 c.c. T.E.L.) Est.	88	....	....

Water Conditioning By Evaporator Method

L. L. WAKEFIELD, The Texas Company

WATER, the most universal of all liquids, presents serious problems in most industries for both chemist and engineer.

In the manufacture of textiles, paper, in cleaning, dyeing, laundering and many other industries where water is used in process work, and in all industries where steam is generated, the organic and inorganic impurities in water play a very important part. Even in pure distilled water there is the probability of free oxygen which will form oxides in engine jackets, boilers and piping, also when free carbon dioxide is present in steam, carbonic acid is formed at the point of condensation and is corrosive to some kinds of metal.

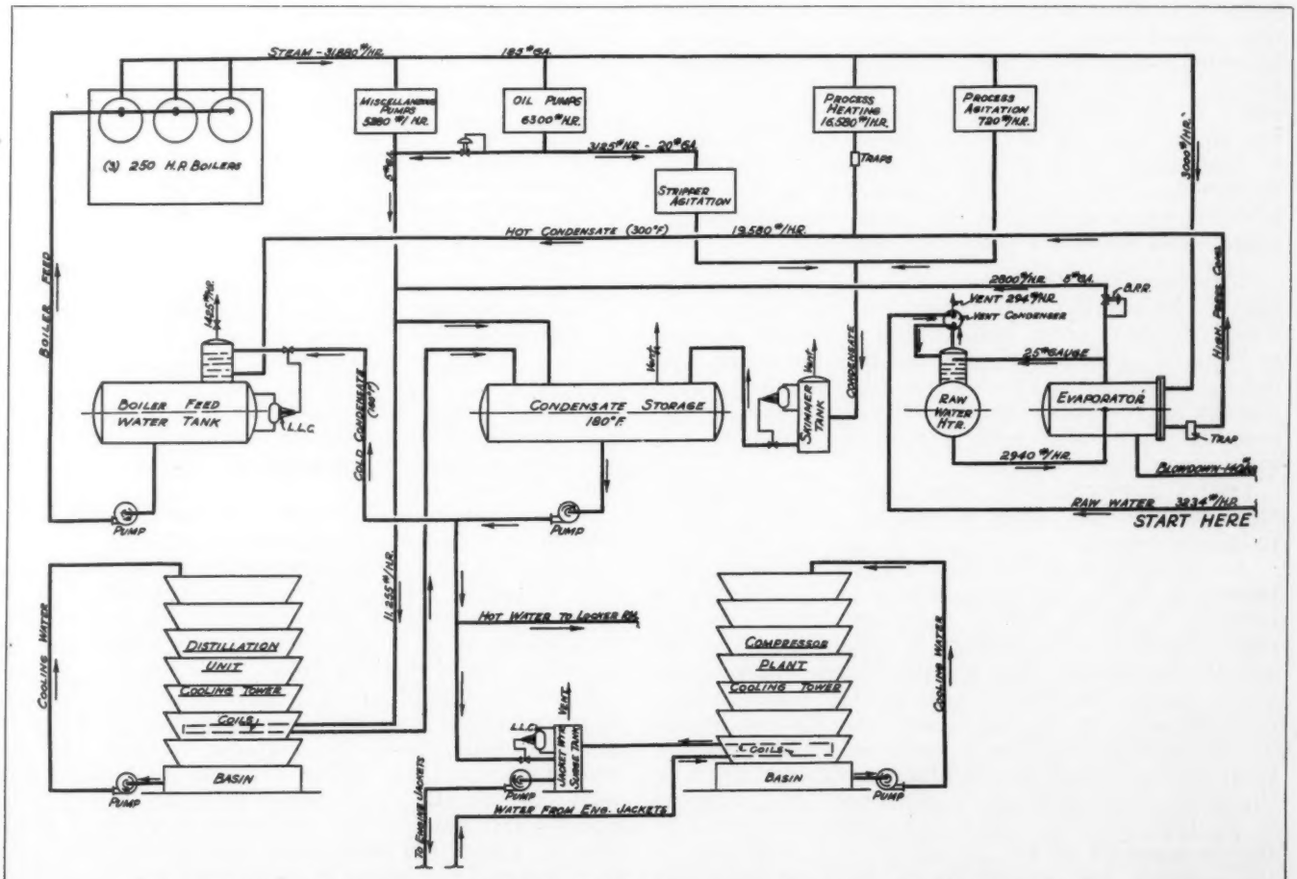
This article will be confined to conditioning boiler-feed water and for engine-jacket cooling water by evaporator methods.

The purpose of a water-conditioning system is to modify or eliminate the solids in the make-up water. Properly designed evaporators for providing distilled make-up water will keep the amount of total solids in the make-up water well below one half grain per gallon, which is equivalent to elimination of solids, even though the water fed to the evaporator has a concentration of 150 to 200 times this amount. However, it must not be considered that evaporation is the optimum treatment for all boiler-make-up waters.

The desirability of an evaporator system, or, in fact, any system, depends upon the operating conditions, steam demands, quality of raw water supplied, and the heat and material balances in each plant. Variations in these factors make each application a separate and distinct problem requiring careful consideration of chemist, engineer and owner.

For sometime after the introduction of the evaporator system the application of evaporators to central power stations received principal consideration. Later, industrial engineers, observing the progress in central-station practice, become interested in the possibilities of evaporators to serve make-up water needs for boilers in industrial plants.

Formerly, the high percentage of boiler-feed make-up required in the typical industrial plant involved



Flow Diagram of the steam cycle in the Shiells Canyon gasoline plant of The Texas Company

such a large investment for evaporators that usually it was difficult to justify their purchase. In recent years many improvements in the design of operating equipment have brought about reductions in water losses thus reducing the amount of make-up required and the practical and economical application of evaporators has been extended to an increasing number of industrial plants.

There are many and varied evaporator installations, but most of them will fall into one of the following three general classifications:

1. Single-effect evaporators.
2. Multiple-effect evaporators.
3. Reducing-valve evaporators.

Single-Effect Evaporator System is one in which one evaporator is used to supply the make-up water to the system, and is generally used where make-up requirement is a small percentage of the total requirement. The typical evaporator system described elsewhere in this article is a single-effect evaporator and is in use at Shiells Canyon gasoline plant, Ventura County, California. About 0.9 pounds of steam is generated in the single-effect evaporator for each pound of steam supplied to the evaporator.

Multiple-Effect Evaporator System is one in which two or more evaporators are set up in series, and is generally used where make-up requirements are large, varying up to 75 percent, and there are even installations for 100 percent make-up requirement.

The Santa Fe Railroad, at Winslow, Arizona, has a three-effect evaporator installation.

From 2.2 pounds to 2.5 pounds of pure distilled water can be obtained per pound of steam supplied to the first-effect evaporator in a three-effect installation. Steam from the boilers is supplied to tubes in first-effect evaporator and, of course, all of condensate is returned to the boilers. Vapor from the first effect is the heating medium for the second effect and so on until the last effect from which the vapor is condensed in some type of condenser. The condensate from all evaporators, including the last one, is collected as distilled water to be used for boiler make-up or whatever purpose intended.

Reducing-Valve Evaporators are one or more evaporators in parallel which generate steam at a reduced pressure from main boiler pressure; a part to be used for process work, and the remainder condensed as distilled water for make-up. The evaporator thereby serves as a reducing valve, frequently being installed in parallel with a reducing valve in the main steam line.

Central power stations often make use of reducing-valve evaporators when supplying steam to other industrial plants.

An installation of this kind recently has been completed at Avon, California, where an oil refinery is located. A public utility company built a power plant adjacent to the refinery to supply it with steam and electric energy. The surplus electric energy goes to the utility distribution system. The public utility company uses the surplus refinery gas for fuel. Steam for the turbine-generator is produced at 1200 pounds p.s.i. and is bled off the turbine to evaporators; here the steam from turbines is condensed and returned to the high-pressure boilers. The steam produced by the evaporators at 185 pounds p.s.i. is delivered to the refinery for process work and for operating pumps, etc. The steam at the power plant is a closed system and requires little or no make-up and the steam for the refinery is produced by the evaporators and is not returned to the power plant.

There is still another use for evaporators that has recently received some consideration among refiners. It is called the hot-tar evaporator, and finds use where cracking or viscosity-breaking units are in operation. Where there is a residuum leaving the unit at from 500° F. to 750° F., and which has to be cooled down by some means before entering tankage, it can be put to work as a heating medium in an evaporator tube bundle much the same as high-pressure steam, and, with raw water around the evaporator tubes, steam is generated up to about 185 p.s.i. gauge. There is one installation of this type generating 34,000 pounds steam per hour. The investment cost and operating cost are very nominal compared to a boiler installation of similar capacity.

Typical Problem

The evaporator system at The Texas Company's gasoline plant at Shiells Canyon will serve to illustrate a typical problem of conditioning make-up water by evaporation.

An analysis of the raw water was as follows:

Ionic Analysis

	P.P.M.	G.P.G.
Silica, SiO2	25	1.5
Iron oxide and alumina, R2 03	1	0.1
Aluminum, Al	1	0.1
Calcium, Ca	182	10.6
Magnesium, Mg	62	3.6
Sodium, Na	103	6.0
Bicarbonate, HCO_3	305	18.0
Sulphate, SO4	586	34.2
Chloride, Cl	53	3.1
Total Solids, by summation	1321	11.7
Total Hardness, as Ca CO_3	706	41.3
Total Alkalinity, as Ca CO_3	504	29.5
P H Value	7.3	
Probable Combinations of Above Ions		
Incrusting Solids:		
Silica	25	1.5
Iron oxide and alumina	1	0.1
Calcium Sulphate, Ca CO_4	618	36.0
Magnesium Bicarbonate, Mg $(HCO_3)_2$	370	21.6
Magnesium Sulphate, Mg SO_4	4	0.2
Total	1018	59.4
Non-Incrusting Solids:		
Sodium Sulphate, Na_2 SO_4	217	12.7
Sodium Chloride, Na Cl	86	5.0
	303	17.7

It will be noted from the above that the raw water in question contained the usual carbonates, sulphates, chlorides of calcium, magnesium, and sodium, also some iron and silica.

Several methods of water treatment were considered.

It is particularly important that an analysis of the raw water to be conditioned be submitted to a reputable evaporator manufacturer for his recommendations as to crackability of scale which will be deposited on evaporator tubes from the raw water.

From the data obtained by chemists and the manufacturers of the various water-conditioning methods under consideration, the engineer worked out the economics for each. When the decision finally was made to use the evaporation method, it was confidently felt that the job had been thoroughly engineered. There had been more than 20 different heat and material balances made before the final flow diagram shown here was adopted.

The system may be briefly described as follows:

Scale shedding is accomplished by alternate heating and cooling of tube sections. With the water spray shut off hot material continues through the tubes to gain maximum expansion. When the cold water spray is resumed contraction helps to break the sleeve-like scale accumulation, as shown left. The condition of tubes is shown above.

The pressure maintained on the raw-water system throughout the plant is about 50 pounds p.s.i. so there is no difficulty in getting raw water into the deaerating raw-water heater which is held at 25 pounds p.s.i., thence to the evaporator. The pressure recommended by the manufacturer for best hard-scale formation in the evaporator was 25 pounds gauge. This is desirable for descaling evaporator tubes. Steam for heating raw water to about 240° F. in the raw-water heater is obtained directly from the evaporator. Oxygen and carbon dioxide liberated in the heater are vented to atmosphere through a vent condenser on top of the raw-water heater and a portion of the non-incrusting solids, such as sodium sulphate and sodium chloride, are precipitated out on the trays and in the reservoir of the raw-water heater. The heated raw water flows by gravity to the evaporator, pressures being equalized through the steam line between evaporator and heater.

The heating medium in the evaporator tubes is high-pressure steam (185 pounds gauge) direct from boilers. Condensate from these tubes is discharged by trap into a hot condensate header. Heated raw water from the raw-water heater enters the evaporator shell around the tubes and high pressure steam through the tubes.

Scale Shedding Procedure

Raw water vaporizes in the evaporator much the same as in a boiler. Pressure is maintained at 25 pounds gauge. A portion of the steam, as mentioned above, goes to the raw-water heater and the remainder goes to the exhaust steam system. Scale formed from raw water in the evaporator is deposited on the tubes where it is cracked off every 24 hours of operation. Every 8 hours of operation, the evaporator is blown down. However, the intervals of cracking and blow down would be governed by scale formation and concentration in evaporator water. Scale deposition on the outside of evaporator tubes is cracked off in the following manner:

Steam to the tubes is shut off; evaporator is then quickly emptied through the 6-inch blow-down line; after which steam is opened full into tubes, expanding them to their maximum curvature (the tubes in the tube bundle are of the bent tube type) steam is again shut off and cold water is turned on full into the evaporator completely submerging tube bundle and splash plate, thus contracting the tubes to their minimum curvature, cracking off the scale; evaporator is again emptied through the 6-inch blow-down line to wash out the loose scale; raw water is again turned into the evaporator, filling it to the proper level, and the operation starts another cycle.

Excess steam from the evaporator is released through a back pressure valve into the low pressure exhaust steam system (5 pounds gauge), and with exhaust steam from boiler feed pumps and circulating water pumps, is condensed in atmospheric condenser coils in a natural draft water cooling tower, using raw water as the cooling medium. The exhaust steam condenser coils are of the bent tube construction as are all other atmospheric cooling and condensing sections in this cooling tower. They are in two parallel banks and are descaled twice a week in much the same manner as the evaporator tubes—that is, by alternately expanding and contracting the bent condenser tubes. Other condensing and cooling sections are descaled at intervals up to six months according to the need.

Exhaust steam fom the oil pumps at 20 pounds gauge is used for agitation steam in the stripper. Steam condensate from stripper agitation steam and fractionator agitation steam is separated from absorption oil and gasoline after which it is returned to a 7000-gallon horizontal condensate storage tank. Also the condensate from the exhaust steam condenser coils in the cooling tower is returned to the 7000-gallon condensate storage tank. This storage tank is blanketed with exhaust steam, for the two-fold purpose of prevention of absorption into the condensate of oxygen from the atmosphere, and to maintain the temperature of the condensate as near that of exhaust

steam as possible. Condensate is pumped from this tank into the boiler feed water tank.

High-pressure hot condensate, about 300° F., from all the traps is returned to the boiler-feed-water tank. The boiler-feed-water tank is not only used for mixing hot and cold condensate but also functions as a final deaerator before the wholly distilled boiler-feed water enters the boilers.

In the dome on top of the feed-water tank are four trays. The cold condensate, about 180° F. to 190° F., enters dome above the top tray. Hot condensate, entering near the bottom of the dome, flashes into steam, along with any oxygen or carbon dioxide which might have been entrained in the hot condensate.

As these vapors flow upward, countercurrent to the cold condensate flowing downward, any traces of free oxygen or free carbon dioxide in the cold condensate is also liberated and, together with a small amount of steam, are vented to atmosphere. Mixed condensate in the boiler-feed-water tank is from 230° F. to 260° F., depending upon the proportions of hot and cold condensate. A small quantity of chemical is fed into the boilers as a precautionary measure to inhibit possible caustic embrittlement. Every three months each boiler is taken off the line and washed out but not scaled, for since the plant was put in operation in 1937 all three boilers have been free from scale and are perfectly clean.

Make-up water for the boilers and engine jackets amounts to about 2 percent of total feed to boilers.

Every 60 days two men require an 8-hour day to clean both the raw-water heater and the evaporator.

The boilers generate about 20,000 pounds of steam per hour.

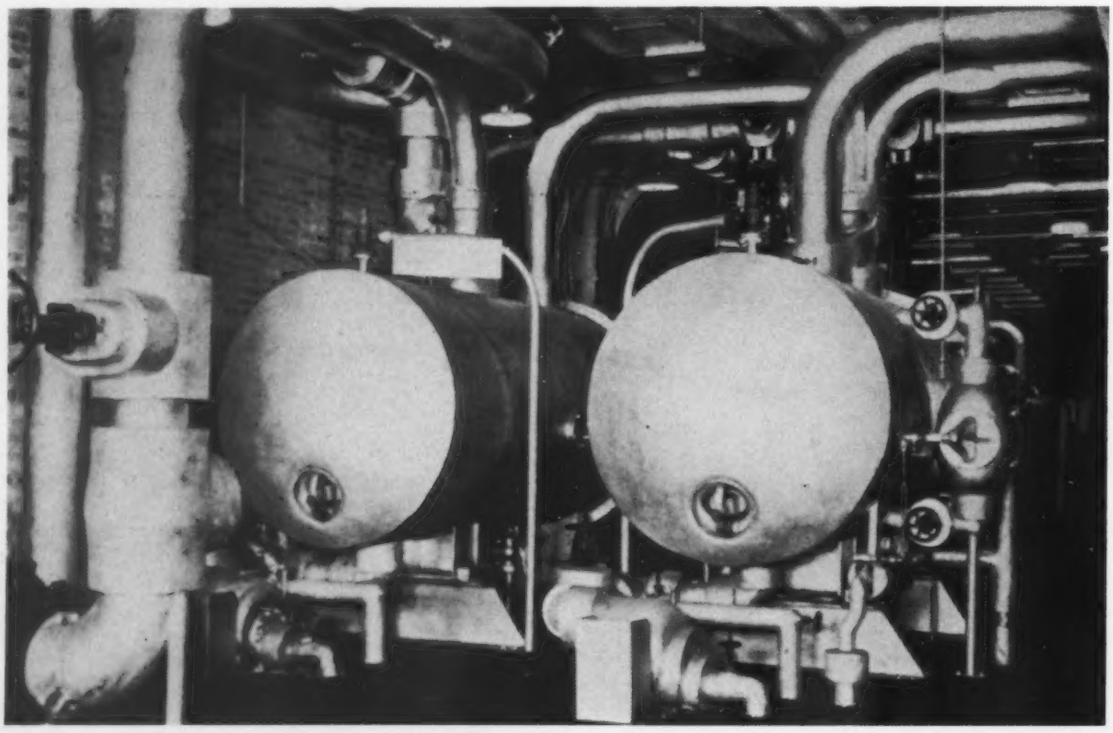
In addition to boiler-water make-up, water for make-up to engine jackets is supplied from the 7000-gallon condensate storage tank. This, however, amounts to practically nothing as the jacket water for the compressors is in a closed system, it being cooled in atmospheric cooling coils in the cooling tower. Engine jacket make-up water is fed into an open-vented surge tank which absorbs oxygen from the air into the jacket water at this point as rust showed up in the engine jackets. This is now being taken care of by the addition of a rust inhibitor.

Some of the features of the evaporator which received particular consideration are as follows:

1. Interchangeability of all interior movable parts.
2. Access to interior of the shell through manholes or large hand holes in both front and rear heads for inspection and cleaning.
3. Heating elements removable without entering shell.
4. Heating surface low in the shell to provide ample vapor space above the tube bundle.
5. Large disengaging surface for the diameter of the shell.
6. Descaling features.
7. A moisture separator which performs the same function as the dry pipe in a fire tube boiler.
8. A splash plate above the topmost tubes to prevent spouting of the water from violent ebullition.

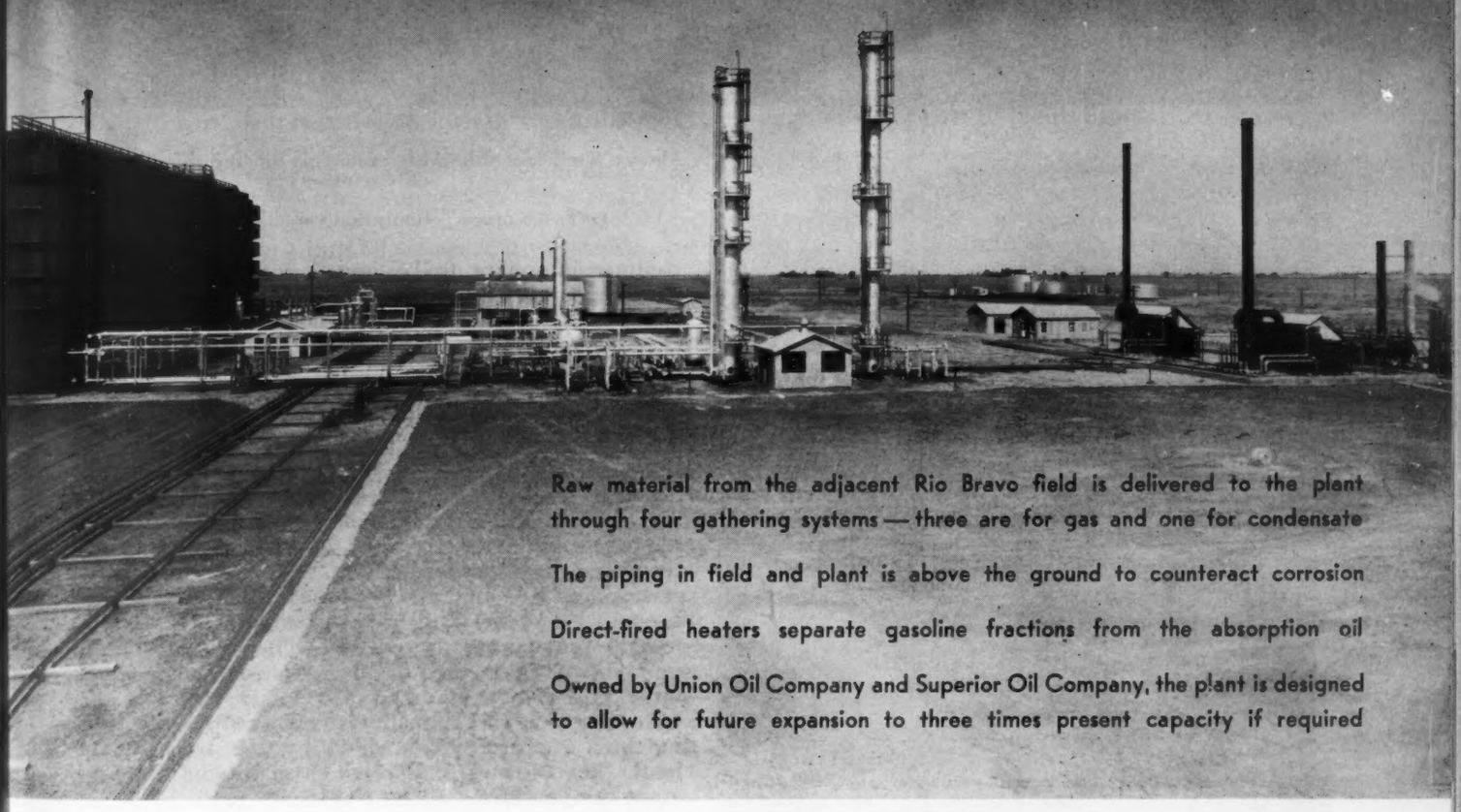
The most salient feature of the atmospheric cooling and condensing sections in the water-cooling tower is their self-scaling feature which permits the use of raw water in the cooling tower.

Regardless of what steam requirements may be, whether it is drilling operations, gasoline plant, refinery or other industrial plant, the importance of water conditioning should not be overlooked. The executive who has the foresight to require a thorough study of steam, power and water facilities is laying the foundation for economical operation.



Typical Evaporator Installation

Multiple-Line Gathering System Serves Modern Gasoline Plant



Raw material from the adjacent Rio Bravo field is delivered to the plant through four gathering systems — three are for gas and one for condensate

The piping in field and plant is above the ground to counteract corrosion

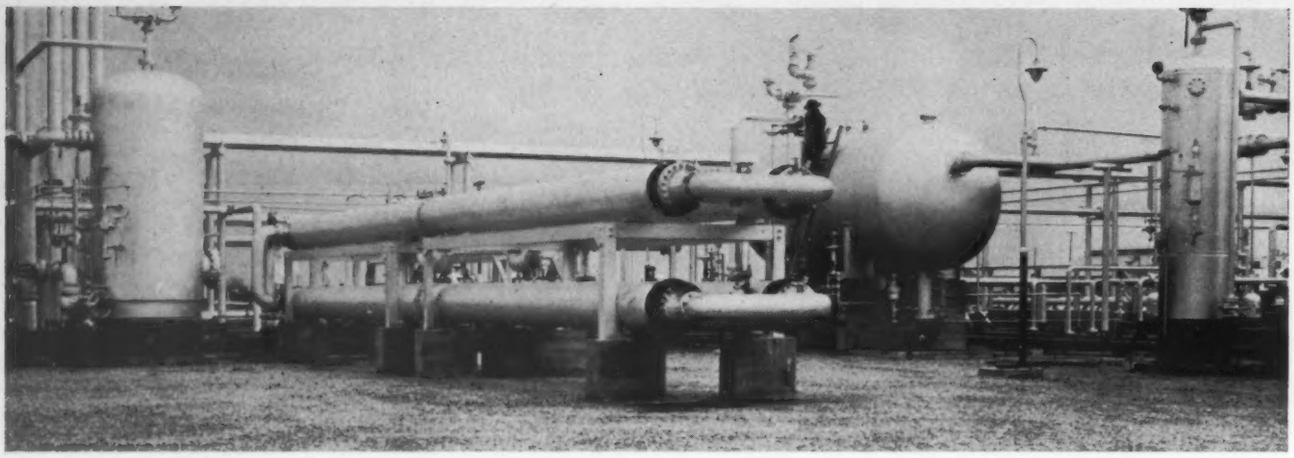
Direct-fired heaters separate gasoline fractions from the absorption oil

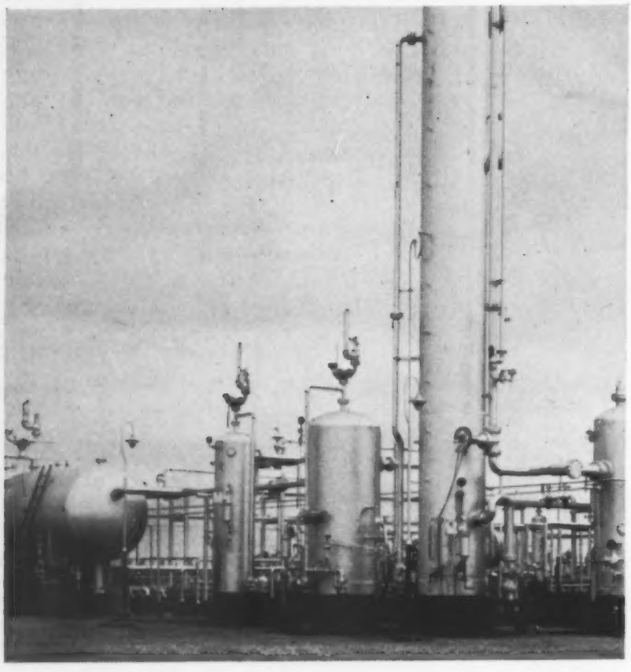
Owned by Union Oil Company and Superior Oil Company, the plant is designed to allow for future expansion to three times present capacity if required

RIO BRAVO field, Kern County, California, being new, gave opportunity for engineers of Union Oil Company to design a natural-gasoline plant in which are incorporated the latest in equipment, gathering system and processing. Wells in the field flow through two stages of separation. The first at 500 pounds allows liberation of 80 percent of the free gas; the second, 80 pounds, releases the remainder. The high-gravity oil gives off vapors at lease tanks, so a third gathering system, under slight vacuum, is provided for tankage. Condensate collects in each of the three gas-gathering systems, so a fourth system, paralleling the gas lines, collect this product in separating tanks from which it is delivered to the plant and processed.

Cooling of the high-pressure gas is necessary, so the system carrying gas from the first separation stage is passed through scrubbers directly to atmospheric sections in the cooling tower before entering the absorber. The second-separation-stage gas is scrubbed, but handled by compressors to boost the pressure to the 450 pounds at the absorber. Field-tank vapors and vapors from several points within the plant also are handled by the compressors, some of them through all three stages to the 450 pounds at which the absorber is operated. Since practically all of the vessels inside the plant are operated at pressures above atmosphere, the 19-inch low-pressure compressor cylinders handle the field-tank vapors and boost them to a pressure of 50 pounds. Gas from the second-stage separation in the field is passed from the scrubbers to the 50-pound accumulator, then picked up by the second-stage compressors and boosted to 150 pounds at the intake of the high-pressure cylinders. All gas handled by the compressors is cooled in the interstage and scrubbed to separate condensate. Condensate produced at high pressure in the plant, as well as that received by the high-pressure gas scrubber is reduced in pressure successively by flowing through the 150-and to the 50-pound accumulator. This practice is followed so that the volatile components of the liquid will vaporize and pass with the gas to the absorber after recompressing and boosting back to 450 pounds in the high-pressure cylinders.

Condensate recovered from field lines by drips





Above: Shell and tube heat exchanger on the mineral seal oil circuit

Left: Absorber column and vent tank battery

and accumulators is blown into the liquid-gathering line and delivered to the plant where the water is remove and the gasoline is used with the plant condensate as reflux for the still. An interface level controller traps out the water from the liquid accumulator and dumps it to plant disposal lines.

Absorption oil is circulated with gang pumps driven by a steam turbine. Hot oil is withdrawn from the still through a motor valve controlling the level in the column and pumped through the heat interchangers to atmospheric coolers in the tower. The second pump picks it up from this point and delivers it to the absorber at the required oil-to-gas ratio.

The absorber is equipped with perforated plates. A motor valve controlling the level in the absorber passes the rich oil from the base of the column into a cold-oil vent tank. Pressure on the rich oil is reduced in this transfer from 450 to 150 pounds to release the lower-boiling fractions. At this pressure, the rich cold oil flows through half of a four-section heat interchanger, counter-current to the hot oil from the still and enters the hot rich-oil vent tank, which is held at approximately 55 pounds pressure. Vapors released in this vessel are returned to the compression plant to be mixed with other vapors, to be recompressed and returned to the absorber after cooling and scrubbing to remove the condensate accumulating in the interstages.

The oil flows from the hot rich-oil vent tank through the remainder of the heat interchanges directly to the still. A divided draw-off pan is placed in the still, from which the partially stripped oil is removed to the suction of the still heater pump and discharged to the direct-fired tubular furnace. This furnace is similar in construction to those used in refinery skimming plant. In the Rio Bravo plant, the direct-fired heater replaces steam preheater. It raises the oil temperature in the return to the still to 475° F., and maintains that temperature, regardless of the quantity circulated. The amount of oil pumped through the direct-fired heater is always large enough to maintain a velocity through the tubes to prevent coking and overheating. The fires in the furnace are controlled by the temperature in the heater transfer line which maintains the constant temperature.

Quality of the vapors leaving the still to the condensers is controlled with pumped reflux. The origin of this reflux is from two sources. First, all condensate from accumulators and receivers on the compression system is pumped to the top of the column. If this is insufficient for temperature control, the reflux is augmented by a stream taken by the same pump from the raw gasoline accumulator. Since liquefied petroleum gases are manufactured at Rio Bravo, the raw gasoline contains all fractions extracted from the field gas, including propane and heavier.

Marketing of both natural gasoline and liquefied petroleum gas requires that the product be fractionated to the desired vapor pressure and specifications. To accomplish this the raw gasoline is both stabilized and fractionated into two liquid products; in addition to the condensate from the top of the fractionator to be used as reflux controlling the operation.

Since the design of the stabilizer provides that it produce two finished streams, the vapor-pressure natural gasoline is taken from the base in the conventional manner. The liquefied gas is produced from the feed to the column and removed from the upper part of fractionator and is controlled to a winter

grade of 130/135-pound and the summer grade of 90/95-pound, with natural gasoline ranging from 17.5 to 24 pound, Reid, product.

The raw gasoline is picked up from the accumulator by a simplex steam pump, and discharged at 275 pounds pressure through the bottom product to charge interchangers and enters the shell of the fractionator. Heating of the material in the stabilizer is obtained by withdrawing a stream of material and pumping through a direct-fired reboiler, whose temperature is maintained so the desired fractionation can be obtained for the required base product. The return from the reboiler is through a line connected to the stabilizer at a point just below the lower plate. The quantity circulated through the direct-fired reboiler is sufficient to maintain the working temperature in the column without excessive vaporization. The heater is controlled with automatic instruments on the circulation and firing sides to maintain the balance desired.

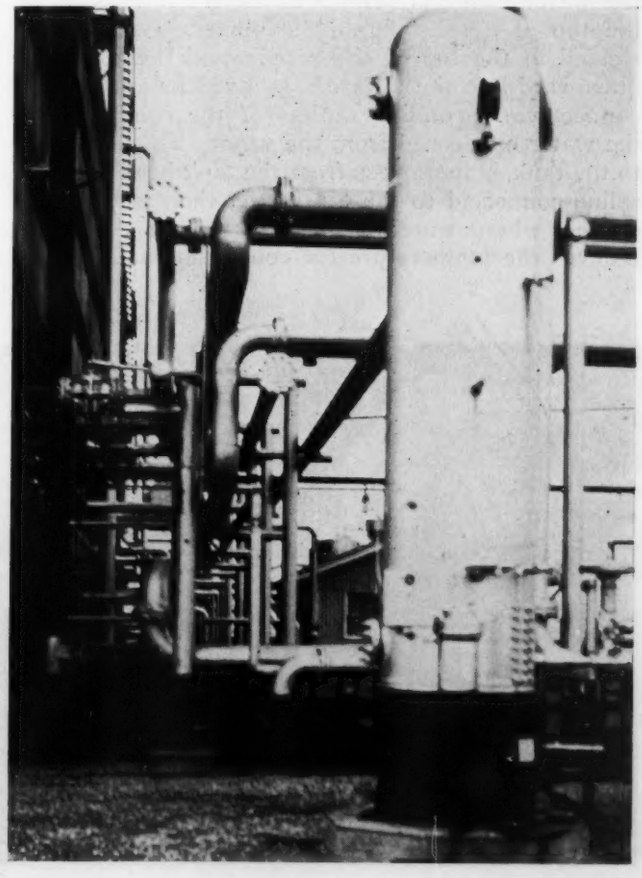
Because the feed to this column contains all the fractions absorbed from the field gas, the stabilized product is composed of that combination of hydrocarbons necessary to produce a given vapor-pressure commodity. If, for example, the product desired must possess a Reid vapor pressure of 17.5 pounds, the quantity of iso and normal butanes is less than for a 24-pound product. Therefore, the excess butanes must pass upwards, in the vapor state, from the feed nozzle toward the overhead uncondensed vapor line.

The composition of the side cut product must be controlled to include the required proportion of butane and propane without an excess of either. Should the desired base product call for a lower percentage of butane, and the side cut demand a lower percentage of butane, the operation of the column must be balanced to obtain both objectives. By virtue of plate fractionation, no butane fraction can pass upward beyond the plate where propane begins to liquify, therefore, the excess butane must be taken from the column before it reaches the side cut withdrawal connection. When the composition of the stabilized gasoline is such, and the composition of the liquified gas permits a definite, unobstructed fractionation on the various plates, the operation of the column is simplified. But when an excess of butane is removed from the product in the base of the column, the excess is withdrawn from plates between the feed and the side cut withdrawal trays.

Process control is accomplished by recording and controlling instruments. A 50-point potentiometer is located on a separate panel across from the main instrument board with 15 circuits in the stabilization system. The temperature at various points is checked frequently, and the overhead reflux to the stabilizer controlled to liquify the required percentage of propane to maintain a balance in the tower and to produce the desired grade of liquefied gas. This reflux is a condensate resulting from cooling the vapors from the fractionator, and the quantity condensed is in turn controlled by the amount in the reflux accumulator. In the vapor stream from the stabilizer are two control valves, with reverse operation to divert part of the vapors to the reflux condensers through one and part to plant disposal lines through the other.

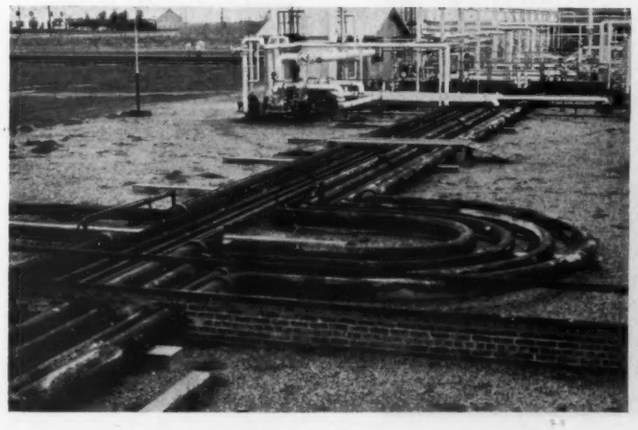
The stabilized gasoline is passed from the base of the stabilizer back through the gasoline interchangers for cooling and then to the plant storage. By-passes have been provided so that the raw gasoline can be pumped from the accumulator to the storage tanks if it is not desirable to fractionate the product. The liquefied gas flows from the side cut draw-off pan through atmospheric coolers to horizontal vessels from which it is pumped to truck and trailer tanks for final disposition.

All piping from the field flow tanks and oil and gas separators to the plant are above ground except at road crossings. The process lines within the plant are on concrete piers well above the ground level so the piping is away from soil contact, and if a leak should develop, it can be discovered quickly.



Right: In the foreground is the scrubber for residue gas which goes into commercial lines. The background shows piping to and from the cooling tower.

Below: Expansion loops on the piping between processing units and the direct fired heaters. Also showing is a section of the brick fire wall between the plant units.



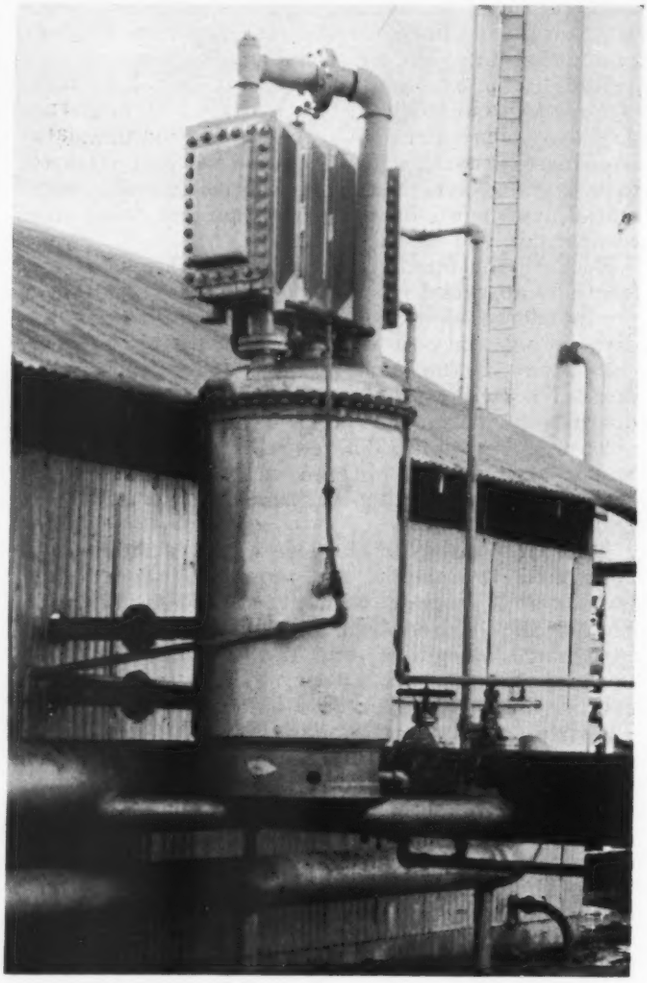
Engine Performance Improved by Maintaining Jacket Water at 210° F

To improve the performance of several multi-cylinder engines in the pump room at the Wilmington Gasoline Company's Terminal Island plant, the engine-jacket water system was changed so that the temperature of the water leaving the machines runs consistently at 210° F. These engines originally were equipped with individual radiators and protective screens having a switch panel mounted at the top of the grill guard. In the change-over, the radiator cores were removed and a common supply tank was installed outside the building.

The engines are in a pit four feet lower than the ground surface, so the water supply tank is set to provide a head of eight feet so the circulating pumps on each engine have flooded suction. Four-inch fittings attached to the supply tank lead to the pump supply and jacket outlet connections with each engine equipped with two, 2-inch lines to the water pumps, and one, 2-inch line leading from the cylinder head outlets back to the header attached to the supply tank.

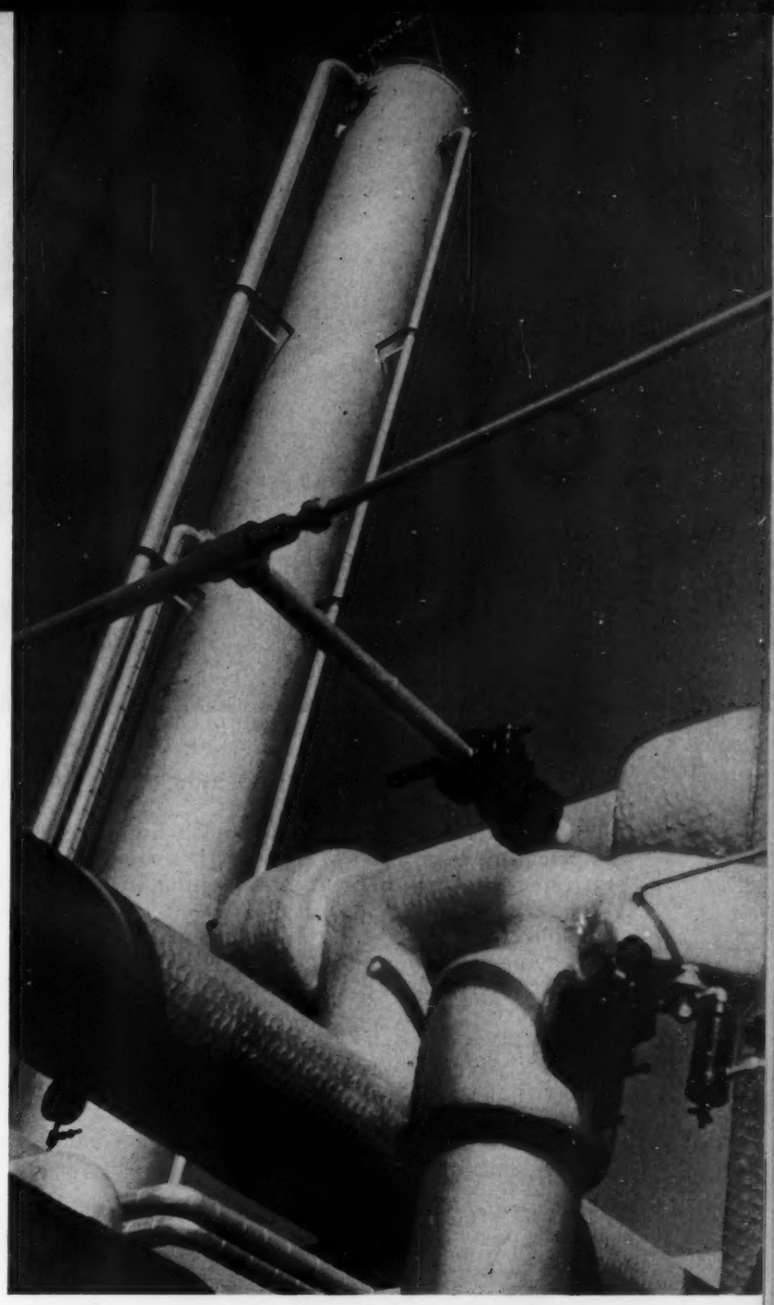
The system is enclosed and any water vapors are condensed and returned to the supply tank by cooling with a shell-and-tube condenser connected directly to the top head of the supply tank. The flow of the water vapor is similar to vapors flowing from the top of a self-refluxing stabilizer. Two nipples welded in the top of the supply tank head extend downward into the water. Bolted unions are used to connect corresponding outlets of the condenser so the water condensed from the vapors will flow back to the tank. Vapors pass from the tank head through a line connected to the top of the shell of the condenser, where water circulated through the tubes reduces the temperature for condensation. Make-up and bleeder lines are attached to the supply tank so the water may be replenished when necessary or the tank drained to remove sediment.

Natural gas is the fuel for these engines, and it is stated that a greater number of hours are obtained from them before it is necessary to replace piston rings, and minor adjustments are practically unnecessary.



The water tank, above, with condenser attached is set to provide a head of eight feet and assure each engine a steady flooded suction.

Automotive type engines, left, run on natural gas. The engines operate without individual radiators and take cooling water from the outside tank, where the temperature is maintained at 210° F.



Fractionating 80-Pound Natural Gasoline

AFTER solving problems connected with processing of separator gas produced with the oil at K-M-A, Texas, to manufacture natural gasoline, including many of the fractions necessary to provide liquefied gases used in aviation fuels, Continental Oil Company is producing a raw material which has an absolute vapor pressure of 80 pounds. Methane and ethane are discarded in this process but the more desirable fractions are liquefied in a composite cut including propane and heavier. By changing the operation of the fractionating column with respect to overhead reflux rate and top temperature, together with synchronous operation of the reboiler temperature and other control factors, all of the propane can be separated from the overhead discard and liquefied with the heavier fractions, or it may be fractionated out as a separate overhead material together with the methane and ethane, leaving any desired grade as a stabilizer base product, even as low as 14-pound natural. Propane and lower-boiling fractions frequently are separated from the heavier base product so that accessory propane chilling equipment can be replenished.

Two purposes were in mind when the plant was changed to the present form. One purpose was to dehydrate the residue and the other, with refrigeration, to extract the maximum of lower-boiling fractions which may be polymerized to normal-boiling gasoline. The phase here described concerns only the processing of raw gasoline to an ethane-free material. Two adjacent plants manufacture a product containing an excess of methane and ethane so that all the propane and heavier are available to this fractionator.

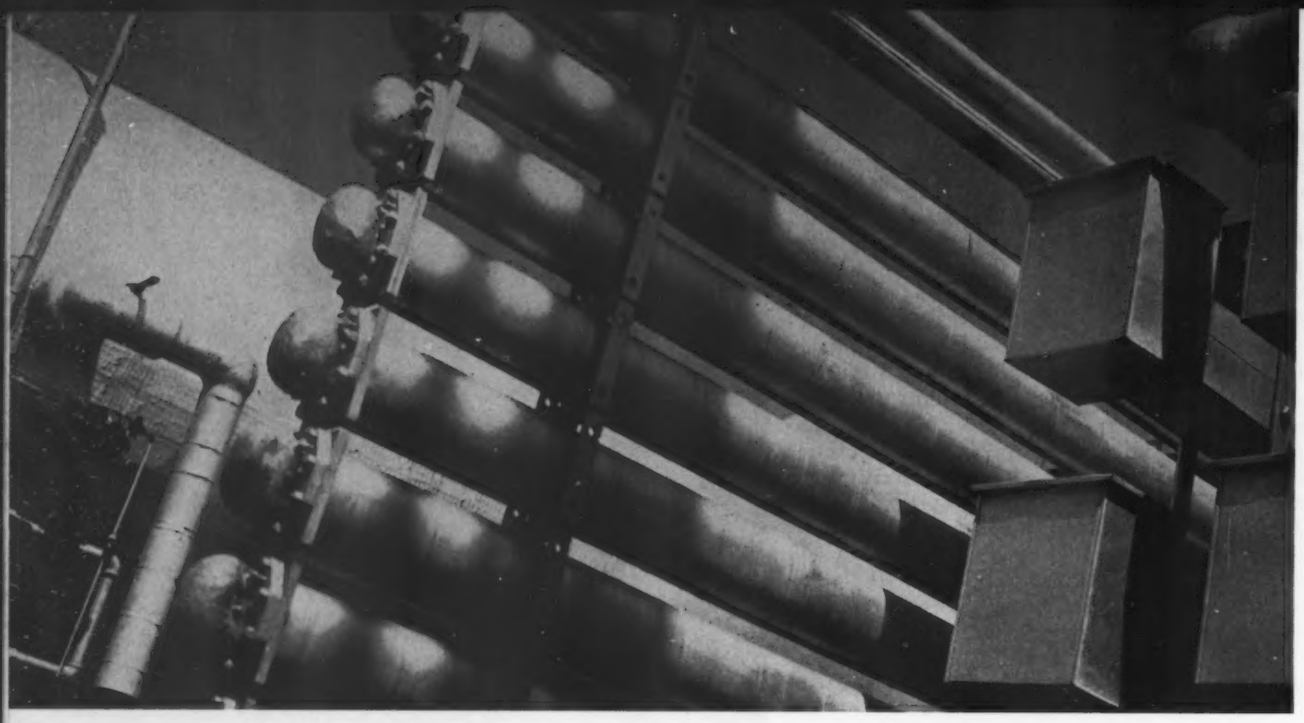
Two plants have low-temperature chilling connected with stage pressure reduction so that most of the ethane is released in the process before it is accumulated for pumping to the central fractionating column. Combined raw gasoline in the surge tank shows the following composition when tested with a low-temperature fractional distillation apparatus:

Raw Gasoline

Fraction	Mol Percent
Methane	None
Ethane	Trace
Propane	38.7
Iso-butane	10.0
N-butane	18.3
Pentanes	20.0
Heptanes plus	13.0
	100.0

Under normal working conditions the raw product reaches the surge tank at a temperature of between 10 and 20° F. The raw charge is held at a pressure of 35 pounds in this vessel and is picked up by a steam-driven reciprocating pump and passed through a series of heat exchangers through which the stabilized product flows counter-current, to raise the temperature to an average of 110° F., so that it will enter the 60-inch by 61-foot high, 31-tray bubble column at the temperature normally maintained at the inlet nozzle. Only one inlet is provided for this column, designed especially for fractionating a high-vapor-pressure raw gasoline to an ethane-free base product.

The column is operated at a constant pressure of 400 pounds, gauge, which is seldom varied, and is one of the column operating constants. This pressure is controlled at a point down stream on the waste gas piping from the accummulator drum so that all operations of the column will remain constant in relation to pressure. To produce a product having an absolute vapor pressure of 80 pounds, the reboiler is maintained at a temperature of 250° F. with steam which passes through a coil within the vessel. This temperature is subject to change as conditions within



the plant vary and the composition of the raw material changes.

This temperature is controlled with liquid reflux, pumped back over the top plate with a steam pump controlled by a temperature controlling instrument. The overhead vapors are all condensed in a bank of atmospheric sections, the liquid and uncondensed gases being received in an accumulator near the base of the column. And when conditions are normal, temperatures ranging about 75° to 80° F. the rate of reflux pumped back over the top of the column is about 1:1. This is based, not on reflux condensed entirely, but the ratio of reflux is about equal to the raw product fed to the column. Under these conditions, the accumulator drum on the reflux condenser sections contains a product whose composition is:

Fractionating Column Residue

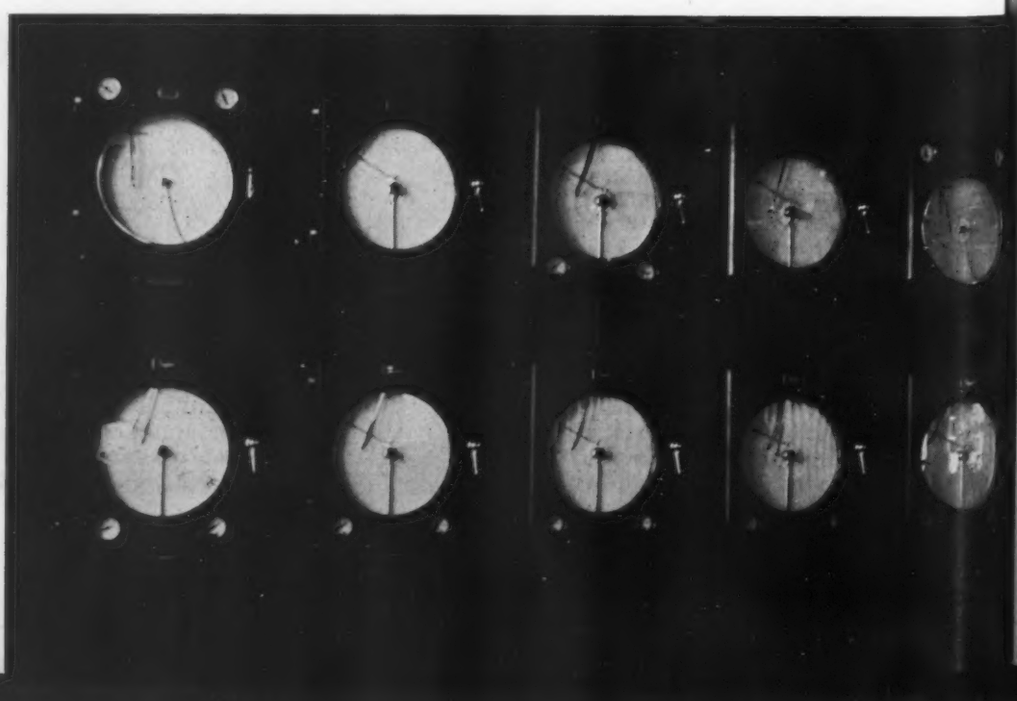
Fraction	Mol Percent
Methane	8.6
Ethane	69.0
Propane	22.4
Iso-butane	Trace
N-butane plus	None

The quantity of propane discarded overhead is misleading since it indicates that the column is not efficient. But when it is shown that, if the reflux to the column is lost, several hours or perhaps a full day may pass before sufficient liquid is trapped in the accumulator to function as a column top controller, it is evident that the actual amount of propane in the overhead when compared to the amount of raw gasoline charged to the column is relatively small.

When the fractionating column is operated at 400 pounds, a reboiler temperature of 250° F., and pumping reflux to the top at a ratio of 1:1 to hold the vapors to a temperature of 105° F., the product leaving the reboiler has the following composition:

Ethane-Free Gasoline

Fraction	Mol Percent
Methane	None
Ethane	None
Propane	29.3
Iso-butane	14.3
N-butane	21.9
Pentanes	24.4
Heptanes plus	10.1
	100.0



Instrument board for the control of fractionation to 80-pound natural gasoline.

Gum and Sulphur Removed From LPG by Filtering

WHEN processing trap, separator and flow tank gases produced with the oil in the Wilmington, California, oil fields, the liquefied petroleum gases, cut from the fractionator tops, contain small amounts of gums that have a tendency to foul regulators and heat exchangers on engines. This product also contains sufficient sulphur to blacken a copper strip. Fouling occurs only after the engine stands over night in cold weather.

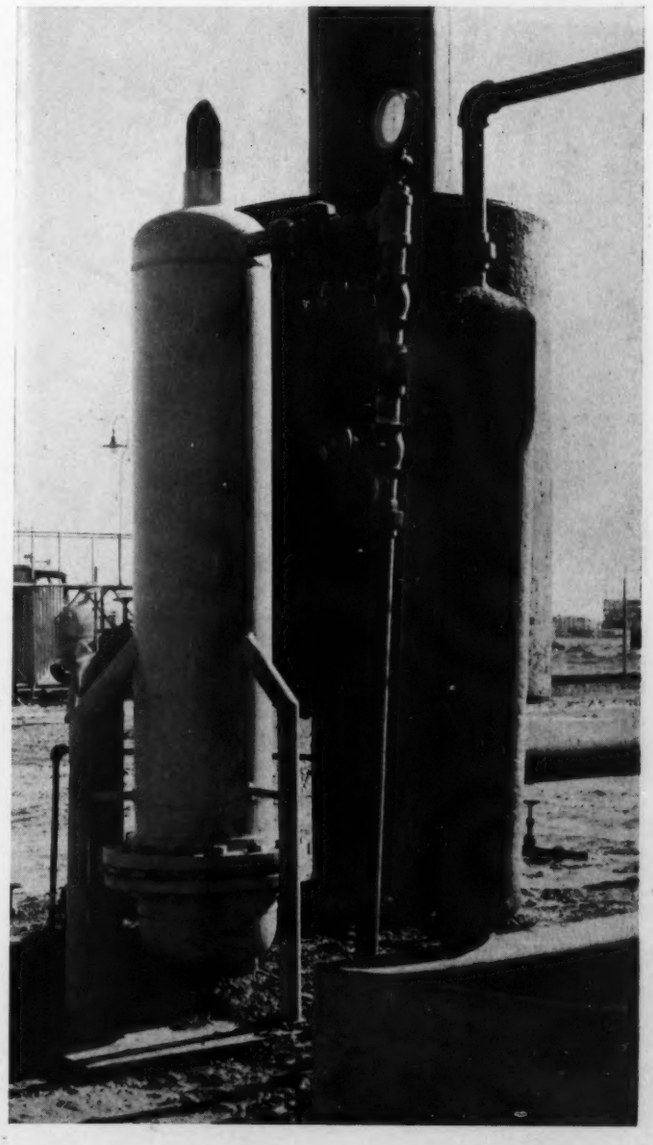
So that either summer or winter grades of liquefied gas can be marketed without gums and sulphur, Wilmington Gasoline Company installed a small treating plant which not only removes the gums and sulphur, but also dehydrates the product.

Liquefied petroleum gases are manufactured by condensing the overhead vapors at the stabilizer with shell-and-tube coolers mounted on the column, and passing the uncondensed vapors from the outlet of these units through atmospheric coolers for added condensation. Since reflux to the top of the stabilizer is furnished by controlling the condenser temperature, both liquid and vapor flow from the column overhead through these additional coolers. The product from the stabilizer overhead vapors were formerly run through a simple settling drum to remove slugs of water, and thence directly to the storage tower so that the first contact with the cold water is upon these sections.

The flow is from the outlet of these coolers through a two-inch line to the back-pressure motor valve at the storage tanks. In the line there is a trap to remove water condensed from the vapor stream so that it will not reach the motor valve and storage. Down stream from the water separator is installed the gum and sulphur filter, placed in the two-inch line so that the flow is in series through the water separator and the filter.

This filter is a vertical drum with a welded head at the top containing a four-inch collar closed with a bull plug. The collar is used for refilling the filter after cleaning. The filter case is mounted on a two-inch pipe tripod support set in concrete at the base of the filter. The lower end of the case has a flange welded to the body to which may be connected a companion flange containing a drum-shaped head and the liquid outlet line. Between the two flanges is placed a slotted plate covered with a strip of filter cloth upon which is placed four inches of hair felt to prevent the filtering agent from passing through the slotted supporting plate. The capacity of the case is 800 pounds of activated clay from Muroc Dry Lake in the Mojave Desert.

Since this filter has been placed in operation, all regulating equipment on engines using this fuel is free from the gummy film and all equipment is operating without disturbance. Tests on the filtered liquid with copper strips show no deposit or discoloration. Not only have the gums and sulphur been removed, but the product passes to storage tanks free from suspended water. No additional equipment is included in the installation which will require observation, and a by-pass around the filter permits removing it from operation when it is necessary to refill with fresh clay.



Cases for the activated clay are between the cooling units and working storage tanks.

Cycling a Factor in California Natural Gasoline Industry

Other 1941 Engineering Trends on Pacific Coast

Separation of Iso From Normal Butane for Alkylation Process in Making Aviation Gasoline.

Single-Stage Recompression of Fat-Oil Vapors and Non-Condensible Vapors for Reabsorption.

Forced-Draft Water Cooling by Internal-Combustion-Engine Power.

Internal-Combustion-Engine Power for Water Pumping.

Compression of Tank Battery Vapors in the Field.

High- and Low-Pressure Distillation.

Direct-Fired Heating.

CONSTRUCTION of two gasoline plants, modernization of a third; erection of special stabilizers for the fractionation of isobutane for alkylation plants; discovery of a distillate field in the San Joaquin Valley which is expected to bring the early erection of a recycling plant, and the drilling of a deep zone at Baldwin Hills which may result in the building of another gasoline plant in the Los Angeles Basin are prominent among the factors indicating that 1941 will be an outstanding year in the Pacific Coast natural-gasoline industry.

Drilling operations which are productive of added wet gas volumes in areas where gasoline plants are already in operation, along with the development of new pools are jointly more than maintaining the industry's production level of about 50,000,000 gallons of natural gasoline per month.

The Los Angeles Basin is the center of considerable interest with the discovery of the Del Valle field near Newhall, 28 miles northwest of Los Angeles. Of added interest is that close to this area the first oil well in California was drilled. The Del Valle Gasoline Company is operating a new gasoline plant on the output from the first two wells. This field is expected to attract considerable offset drilling throughout the year and augurs an increase in natural gasoline output.

In the old Baldwin Hills field, 10 miles west of metropolitan Los Angeles a deep test has opened additional sands which are expected to yield sizeable volumes of fairly rich gas. This may eventually bring about the removal of an idle gasoline plant from the Inglewood field and its installation nearer to the new gas source.

Seven miles southwest of Los Angeles both the Athens and Rosecrans areas have been extending southward but increase in the wet gas output is being handled by the gasoline plants operated by Union Oil Company, Universal Consolidated Oil Company, Cowan and Ryan Gasoline companies. Increased volumes in the eastern section of the field brought about the recent addition of another low-pressure absorber to the Cowan plant.

The Wilmington field, 21 miles south of Los Angeles, was the most active area in the state last year with 158 completions. The field should continue to expand during 1941 but there is little prospect for a new gasoline plant. General Petroleum Corporation's 35,000,000-cubic-foot plant, Wilmington Gasoline Company's 17,000,000-cubic-foot plant and Lomita Gasoline Company's pickup booster to the latter's Signal Hill plant 5 miles away evidently have ample capacity for any immediate field expansion.

Nineteen gasoline plants treat the wet gas from Signal Hills, Santa Fe Springs and Huntington Beach, and all have capacity for increased volume.

Considerable wildcatting is under way along the Pacific Coast between Los Angeles and Santa Maria,

but no developments are in the offing as yet which would yield wet gas in a sufficient quantity for treatment beyond the capacity of gasoline plants at Ventura Avenue, Capitan, Elwood, Rincon and Santa Maria.

First Recycling Plant

The biggest news to come out of the San Joaquin Valley since the discovery of Kettleman Hills is that the newly discovered Paloma field 18 miles southwest of Bakersfield is a distillate-type structure, exhibiting the phenomena of retrograde condensation. Of significance is the fact that the distillate characteristic was learned about in time to permit a full-scale consideration of the potentialities of the discovery prior to exploitation.

Another area in the Valley important to natural gasoline is that made up of Coles Levee and Richfield-Western. These structures are 25 miles southwest of Bakersfield and north of the old Buena Vista gas field. This section was the second most active in the state last year. Wet gas production is handled by Richfield Oil Company's new gasoline plant.

Continued development of Coalinga Nose is yielding wells of such low oil/gas ratios that the erection of the gasoline plant scheduled by Standard Oil Company sometime ago is still indefinite. Wet gas from new wells in the Ten Section, Greely and Rio Bravo fields is handled by existing high-pressure absorption plants.

The Paloma Discovery

No one anticipated that California would have a distillate field. With the increase of technical knowledge on the pressure-volume relationships of gas and oil had come the suspicion that possibly the upper Temblor sands at Kettleman Hills could have been exploited better by recycling. When Kettleman first came in much light-colored distillate was produced.

With the knowledge that the gas in Paloma has retrograde characteristics, installation of the first Pacific Coast recycling plant has become a certainty after a satisfactory unitization plan has been worked out. The principal operators in this area are Western Gulf Oil Company, Ohio Oil Company, Union Oil Company, Barnsdall Oil Company, The Texas Company, Superior Oil Company, General Petroleum Corporation, Standard Oil Company, Kern County Land Company, with other operators holding promising acreage. The field development to date consists of five completed distillate wells, with two more drilling. The gravity of the produced distillate is close to 52° A.P.I.

A workable unitization plan, possibly along the lines of the Kettleman North Dome Association, is considered essential if the full potentialities of the structure are to be realized. A group of consulting engineers are at work on a field survey which it is hoped will yield the boundaries of the area to be unitized, and the type of unitization structure and management which should be set up.

Preliminary indications appear to point to the need for at least a 100,000,000-cubic-foot-per-day recycling plant, probably of the absorption type, which will take field gas at about 2250 pounds and compress it to about 4000 pounds for injection. Some observers consider that the present wells would do well as injection points. If the unitized operation of Paloma becomes a reality the prediction has been made that the yield of oil will be 75 percent greater than if recycling were not carried out.

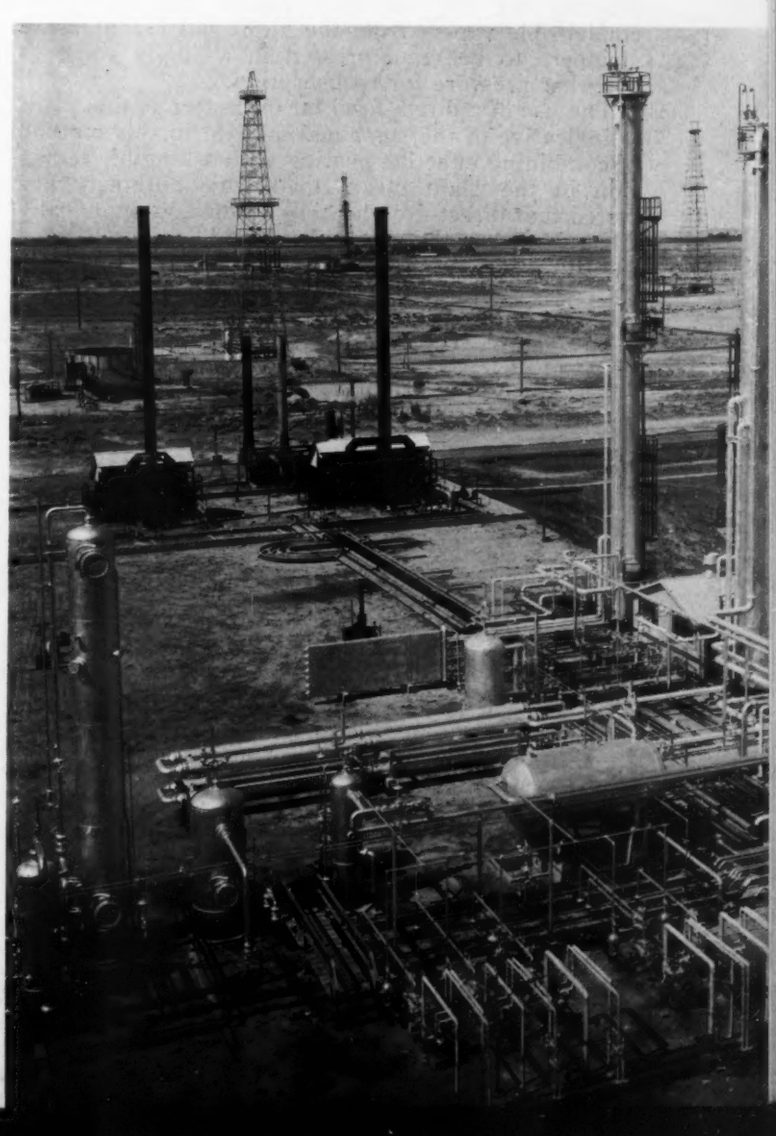
The Paloma field was discovered in the summer of 1939 jointly by the Western Gulf Oil Company and The Texas Company. At 10,178 feet a yield of 50° A.P.I. distillate with high-pressure gas was found. Most of the present production at Paloma reportedly comes from the Stevens zone, which also yields black oil at Coles Levee, Greely, Ten Section, Strand, and Canal.

Gasoline Plant Developments

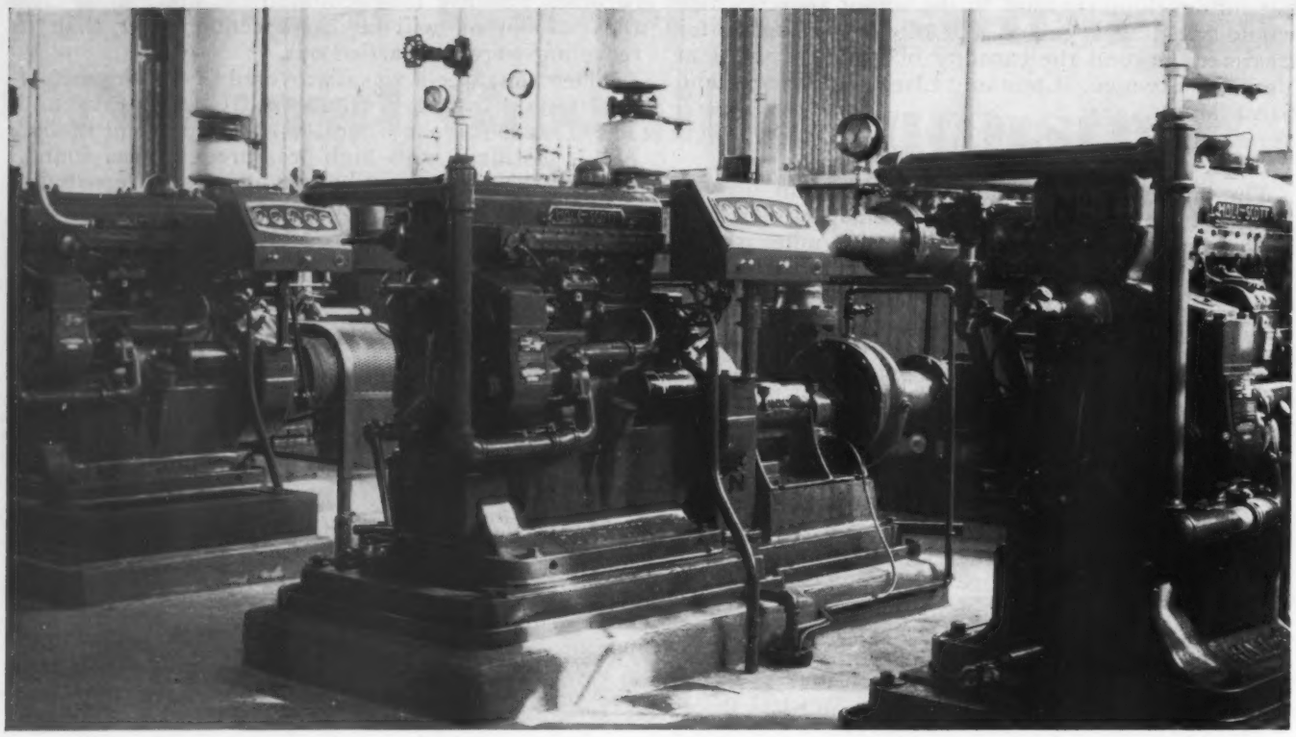
In the Richfield-Western section of San Joaquin Valley, Richfield Oil Company has built a two-unit high-pressure gasoline plant operating at 450 pounds pressure with a daily capacity of 40,000,000 cubic feet. Natural-gasoline production capacity is expected to soon reach 20,000 gallons daily of a 22-pound Reid product.

Among the interesting features in the new plant are: a direct-fired oil heater, a combination high- and low-pressure distillation system, an absorption-oil reclaimer, an oil-heated stabilizer reboiler, and gas-engine driven pumps circulating cooling-tower and engine-jacket water.

All of the wet gas enters the plant at absorber pressure. This is a novel departure over the older combination low- and high-pressure gathering systems. To equalize the pressure, all of the low-pressure gas and tank vapors are picked up by automatic booster compressors in the field and the pressure raised to equal that of the incoming high-pressure



Direct fired heaters and piping arrangement in a new plant in the Rio Bravo field



Adaptation of internal combustion engine power for water pumping as used in a California installation

gas. All vapor-venting in the plant cycle is done between 175 and 300 pounds per square inch. This permits the fat oil vent vapors and the non-condensible vapors from the high- and low-pressure strippers to be recompressed in a single stage to absorber pressure for reabsorption.

The use of a direct-fired fat oil heater at this plant is indicative of the sustained interest in this method of combining effective heating with a tangible reduction in the plant steam load. One authority has stated that direct-fired heating becomes economically attractive when the overall heat load exceeds 10,000,000 Btu. per hour. Another vital factor to be observed in the use of direct-fired heating is that the absorption oil must be clean and free from sludge bodies which might carbonize in the tubes. The oil is kept clean by the use of a reclaiming unit. At the Richfield plant the oil heater is fed from a take-off two or three trays below the fat-oil-fractionator feed plate.

Crude Oil Topping Conserves Butanes

Operating adjacent to, but not a part of, the Richfield Oil Company's gasoline plant is a special fractionating column for removing propane and lighter fractions from the crude oil produced in the field in order to reduce flash-evaporation losses and thereby conserve the iso and normal butane content in the crude. This is accomplished by continuously taking about a 10 percent cut from the crude in a topping still. The cut is then sent to a stabilizer where the propane and lighter fractions are removed. The bottoms from the stabilizer are then blended back with the pipe line oil.

Del Valle Gasoline Plant

Near Newhall, Del Valle Gasoline Corporation's new plant operates at 450 pounds pressure and is designed to handle about 20,000 cubic feet of gas daily. The plant is operating on the output of two wells and is producing about 5000 gallons of what will be an eventual output of 12,000 gallons daily of 26-pound Reid natural.

The incoming wet gas is scrubbed and sent to the first stage of compression at a 25-pound suction pressure. After the first stage the compressed gas is cooled, sent through another scrubber and then compressed to the absorption pressure of 450 pounds. The oil circulation rate through the absorption towers is about 125 gallons a minute.

Tank-farm vapors tie into the gasoline plant system by a simple procedure of compression from atmospheric pressure to the field trap pressure where the vapors then commingle with the incoming wet gas.

The absorber at this plant is a novel combination of both absorber and two stages of scrubbing. Three plant units are built into one shell. The base of the absorber contains the inlet gas scrubber followed by a central section of 16 bubble-cap absorption plates. Above the absorber section, and part of the same shell, is the outlet scrubber.

The plant is virtually of full-automatic operation. After the lean oil rate is set, automatic liquid level controllers and audible signal alarms perform most of the work. Even the reflux for the stabilizer is controlled by a novel system which regulates the condensation of only that amount of reflux required, the rest of the vapor being vented. Audible signal alarms operate in connection with high- and low-pressure vent tanks, scrubbers, cooling water discharge, and the zeolite softening units.

For Alkylation Synthesis

The modernization of the Superior Oil Company's Kettleman Hills plant to bring about the production of propane, butane and isobutane as separate hydrocarbons for commercial utilization was the first major plant change which heralded the important role to be played by the natural-gasoline industry in supplying

isobutane as a basic ingredient for the synthesis of iso-octane by refiners. The separation of propane from the butanes was a well known procedure, but the additional step to separate iso from normal butane emphasized a trend which few had thought would ever become a commercial reality of such proportions.

Since this major change was accomplished, many gasoline operators are beginning to install or revamp stabilizers for a closer cut between propane and isobutane in order to supply refiners with a natural gasoline high in iso and normal butane which can be split up in the central stabilizing plants at the refineries.

At the Superior plant the original battery of five high-pressure absorbers was altered by converting one into a reabsorber operating at 200 pounds for the treatment of all recycled vapors. Other important alterations consisted of the installation of propane refrigeration for cooling both absorption oil and wet gas, and the inauguration of the use of a forced-draft cooling tower in conjunction with an atmospheric cooling tower.

The hydrocarbon fractionation is carried out by means of three columns. The main stabilizer acts as a depropanizer. It is a 60-inch 40-tray column operating at 240 pounds and with a bottom temperature of 270-275° F., a top temperature of 105-110° F. and a reflux ratio of 2.5 to 1. The debutanizer is also a 60-inch 40-tray column, but operates at 94 pounds and with a reboiler temperature of 217° F. and a reflux ratio of about 4 to 1. The de-isobutanizer is a 48-inch 45-tray column 80 feet high operating at 115 pounds with a reboiler temperature of 150° F. and a reflux ratio of about 12 to 1.

Forced Draft Cooling

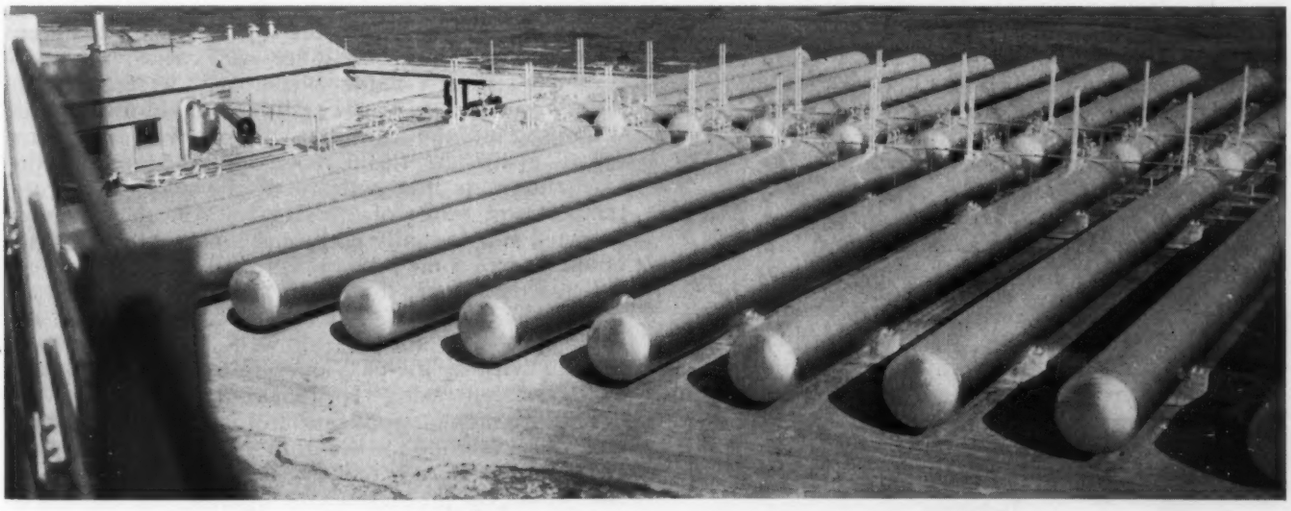
Prominent among the special topics relating to gasoline-plant engineering which are receiving increasing attention from Pacific Coast engineers are those concerned with forced-draft cooling towers, and engine cooling. While the refiners have been using forced-draft cooling for some time, gasoline-plant engineers have been slower in realizing the benefits from this form of tower operation. Up to the present only four gasoline plants have installed forced-draft towers.

In commenting on the forced-draft tower one source states, ". . . While costing more than a 5-mile-an-hour standard cooling tower the forced draft unit has many real advantages which frequently outweigh the additional first cost. Some of the important factors advanced are: (1) that the tower is smaller and more compact than an equivalent atmospheric tower; and (2) that being smaller, construction costs are lower—particularly in the amount of concrete used. The spray loss is lower and the tower can be located much closer to other plant equipment. The smaller size enables tower installations in plant yards with limited space . . . "

At Barnsdall Oil Company's Rancho San Francisco gasoline plant, oil and water are being cooled by the unusual procedure of circulating these liquids through a vane type radiator resembling an automobile radiator. A fan forces air through the vanes and efficient cooling is said to take place. Units are in operation which handle loads of between 1200 and 3000 horsepower. Gas can be cooled by the same procedure with the exception that the radiator section differs in construction.

Considerable data have been accumulated which show, it is reported, that the improper water-cooling of engines results in the condensation of exhaust vapors on cylinder walls with corrosion following in many instances. The condensed vapor frequently finds its way into the crankcase, contributing to sludging and emulsification.

One of the latest trends finds the use of circulating water of a much higher temperature than that formerly used preferable. This is accomplished by utilizing the latent heat of water to do the cooling. Hot water at 212° F. is circulated through the cooling jacket and allowed to pick up heat. On leaving the engine the hot "cooling" water passes through a flash tank where any steam is liberated, and is then sent back to the engine. No temperature control is necessary as the boiling point of the water maintains a uniform temperature.



Liquefied petroleum gas storage concentration at Long Beach

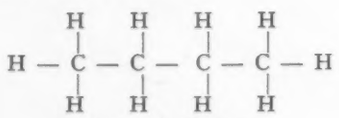
Isomerization for Alkylation Feed

L. J. COULTHURST, Foster Wheeler Corporation

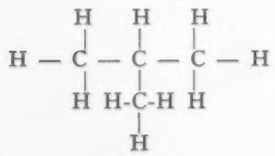
THE process of alkylation has become famous within the last year as an effective and efficient method of producing quantities of high-octane blending stock which is used as the main ingredient for 100-octane aviation gasoline. Alkylation brings about a direct combination of butylenes (C_4H_8) with isobutane (C_4H_{10}) to produce saturated isoparaffin hydrocarbons including iso-octane (C_8H_{18}). Not every refiner has easy access to isobutane in commercial quantities for use as alkylation feed stock but nearly every one has an ample supply of normal butane, which is the most abundant of the 4-carbon-atom hydrocarbons found in petroleum. It is now commercially practicable to convert most of this normal butane to isobutane by the process of isomerization and thus make possible the alkylation of large quantities of butylenes that are available.

Chemists have long applied the term "isomerism" to a phenomenon characteristic of many organic compounds, including those occurring in petroleum, which have the same percentage composition and molecular weight, yet exhibiting different physical properties. These compounds are called "isomers," signifying equal measure. In seeking an explanation of this phenomenon, chemists came to the conclusion that if a molecule of two substances contains the same number and kinds of atoms in the same relative proportions, the difference between the two must be caused by a variation in the arrangement of the atoms within the molecule.

For example, there are two substances which have the composition and molecular weight represented by C_4H_{10} (four carbon atoms and ten hydrogen atoms combined to form one molecule). It is evident that the formula must be written in two ways if there is to be a distinct differentiation between the two compounds. Two possible arrangements of the atoms in a molecule of this composition suggest themselves and they can be represented thus:



Normal Butane



Isobutane

Graphic formulas such as these, in which the containing power of the elements is represented by a line, are the means by which chemists are able to explain the phenomenon whereby two compounds may have the same proportional and total weight of individual atoms, as do iso- and normal butanes.

Some of the basic principles of isomerization were published by a group of Russian chemists five years ago.[1] They demonstrated the possibility of rearrangement of low molecular weight, straight-chain paraffin and olefin hydrocarbons, in the presence of catalysts and without cracking or polymerization, to form branch-chained iso-paraffins. These isomeric compounds are extremely valuable in aviation and automobile fuels since they have higher anti-knock values than the normal hydrocarbons, as well as higher susceptibilities to lead treatment. Isobutane, as a branch-chain paraffin hydrocarbon, is no exception with respect to these qualities, but due to its volatility, its use as a component of internal-combustion-engine fuels is extremely limited. Its greatest potential value, however, lies in its availability for feed stock to an alkylation unit in which it is coupled with butylenes to form valuable alkylate.

Some idea as to the commercial potentialities of isomerization of normal butane to isobutane may be obtained from a recent publication of laboratory results reported by two Russian research chemists.[2] The tests demonstrated that, in liquid-phase operation, approximately 74 percent of the normal butane may be converted to isobutane by isomerization at 158° F. using a mixed catalyst, $CuSO_4 \cdot 2$ HCL plus aluminum chloride ($AlCl_3$). Since these tests were made in closed tubes, the 74 percent conversion of normal to isobutane is an indication of equilibrium concentrations which is the maximum conversion to be expected by recycle operation.

At the same time that the liquid phase tests were made, even a larger number of experiments were conducted in the vapor phase over a temperature range from 158° to 356° F. Aluminum chloride, alone, was used as the catalyst with anhydrous hydrochloric acid added to the normal butane feed in order to maintain proper activity of the catalyst. In the temperature range of 158° to 230° F. the chemists reported substantially no by-products while at higher temperatures some propane is found. The tests would indicate, therefore, that operation from 158° to 230° F. is to be preferred. The results of operation in the vapor phase at 266° F. showed 37.2 percent conversion with single-pass operation and a maximum of 67.3 percent using repeated recycling.

The commercial application of isomerization offers a practical method for the conversion of the relatively cheap normal butane to isobutane in a mildly exothermic[3] catalytic process which operates in the vapor phase at low temperatures.

[1] Zhurnal Obshchei Khimii, U.S.S.R. Vol. 5, No. 7, pp. 972, 976, 1935.
[2] Moldavskii and Nizovkina, National Petroleum News Vol. 32, p. R422-428 Nov. 27, 1940.
[3] Parks, Schomate, Kennedy & Crawford, J. Chem. Phys., 5, 359 (1937).

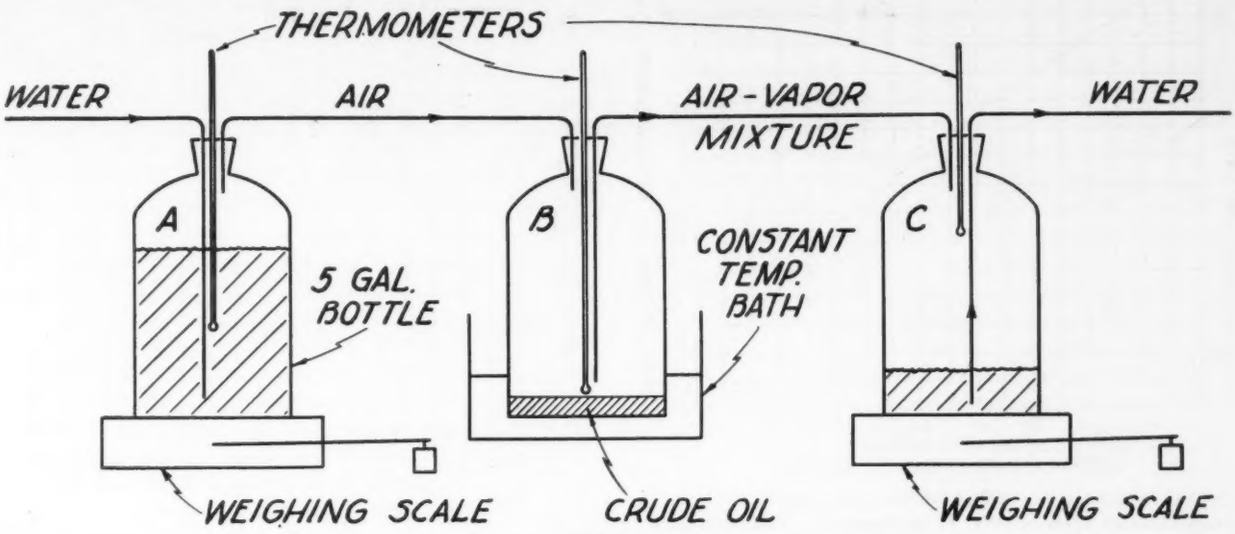


FIGURE 1

Experimental apparatus used in air-vaporization tests on Seminole crude and crude-gasoline blends.

Elements of Vaporization and Condensation

Part XIII

The Transportation and Storage of Crude Oil and Crude-Natural Gasoline Blends

R. L. HUNTINGTON, University of Oklahoma

IT has been found that the blending of small percentages of stabilized natural gasoline with crude oil offers several economic advantages in the transportation and storage of these commodities. There are, however, certain unfavorable factors which arise from this blending practice such as:

(1) Increased vaporization losses in storage.
(2) Fire and explosion hazards in cleaning out tank bottoms which have settled out of crude oil-natural gasoline blends.

Advantages of Blending

The first advantage to be recognized from the pipeline transportation of the crude oil-natural gasoline blends was the large saving in freight. In the early twenties heavy outage losses were experienced in the tank-car shipment of unstabilized gasoline. By blending from 1 to 2 percent of this "wild" gasoline with crude oil, vaporization losses were reduced materially below those suffered through rail transportation.

Reduction in the viscosity of the crude oil is another factor in favor of blending. This change in the physical property of the liquid brings about a saving in horsepower required to pump the crude, due to the lowering of friction losses.

Blending operations are also found to be desirable for some crudes which are high in paraffin-wax content. The natural gasoline acts as a solvent under certain conditions thereby lessening the tendency for wax to form a coating on the inside walls of the pipe line. The alternative of heating the crude and maintaining it at a temperature above the pour point is entirely out of the question for long pipe lines in cold weather. One company has increased its crude oil

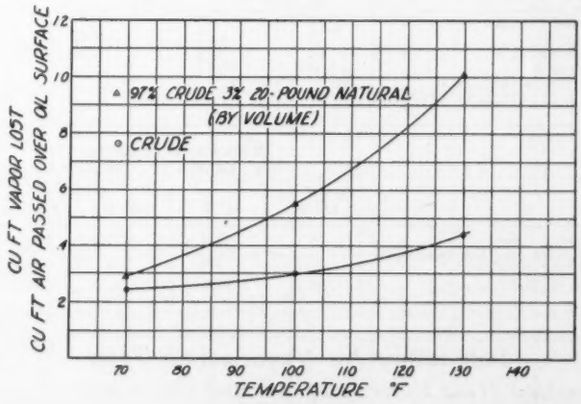


FIGURE 2

Air-vaporization tests. Air flow over crude and blend in five-gallon bottle. Air mass velocity over crude oil surface = .0675 pounds per hour per square foot.

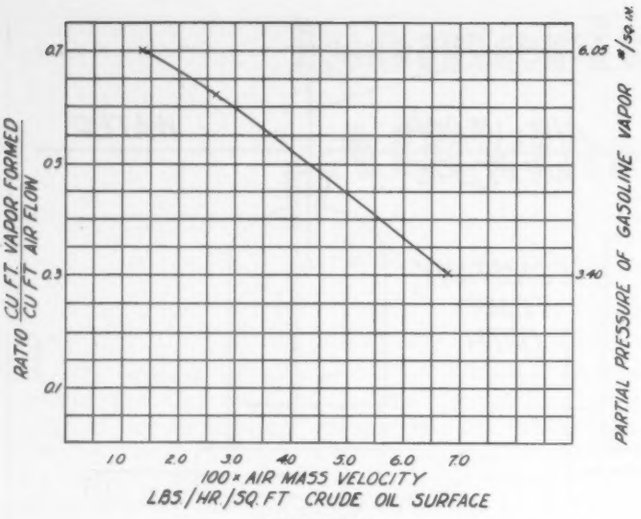

RATIO CU. FT. VAPOR FORMED / CU. FT. AIR FLOW
PARTIAL PRESSURE OF GASOLINE VAPOR #/SQ. IN.
100 × AIR MASS VELOCITY
LBS/HR/SQ. FT CRUDE OIL SURFACE

FIGURE 3

Air-vaporization tests at 100° F. on Seminole crude oil, 38.8° API, 3.46 pounds per square inch Reid vapor pressure. Effect of air velocity over surface of crude oil.

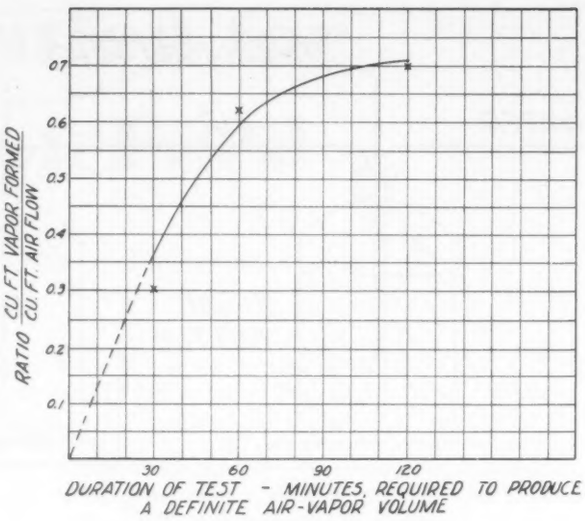


FIGURE 4

Air-vaporization tests at 100° F. on Seminole crude oil, 38.8° API, 3.46 pounds per square inch Reid vapor pressure. Effect of air velocity over surface of crude oil (from same experimental results as shown in Figure 3).

deliveries 50 percent by blending natural gasoline (10 percent by volume) with crude oil in the winter season. This crude has a pour point to 55° F., due to its high wax content. Evaporation losses were not excessive, as much smaller percentages of gasoline were required in summer, to effect the same delivery capacity for the pipe line.

Evaporation Losses

A comparison of the actual losses in large storage tanks is difficult to make due to the frequency of transfers into and from such tanks. Laboratory tests were therefore made on a blend from a representative field in Oklahoma in order to determine the relative vaporization losses. A blend was chosen consisting of 3 percent by volume of (26 vapor pressure at 100° F.) natural gasoline and 97 percent at 38.8° A.P.I. crude oil from the Wilcox zone of the Seminole field. True-boiling-point fractionations were made at low temperatures on the Seminole crude oil, 26 natural gasoline and the 3 percent natural-97 percent crude blend. The tests are as follows:

	Crude Oil (Mol %)	Blend (Mol %)	(26-70) Natural Gasoline (Mol %)
Propane	.38	.55	.....
Isobutane	.64	5.17	2.44
Normal Butane	3.23		37.50
Isopentane	1.37	6.26	28.90
Normal Pentane	3.73		
Hexanes	7.78	8.10	16.12
Heptanes	7.51	9.18	15.04 (C_{7+})
Octanes +	75.36	70.74	.....
Mol Wt. of Octanes +	192	.....	.....
A.P.I. of Octanes +	33.3	.....	.....

	Reid Vapor Pressures Lbs., per Sq. In. Absolute			
	A.P.I. at 60° F.	70° F.	100° F.	130° F.
Seminole Crude	38.7	3.4	6.4	10.9
Blend { 3% Natural Gasoline... 97% Crude	39.7	3.8	7.3	12.1
26-70 Natural Gasoline	88.1	15.8	27.4	43.7

Laboratory Air Vaporization Tests

Constant Mass Velocity of Air and Different Temperatures

In Figure 1 a diagrammatic sketch shows the small-scale apparatus which was used to duplicate, in a measure, conditions existing in a storage tank subject to air infiltration at night and air-vapor exhalation by day. These tests were made under steady state conditions at several temperatures and at different rates of air flow, in order to determine the approach toward equilibrium conditions. In Figure 2, the results of six of the air vaporization tests are given. It will be observed that at 70° F., the relative volatility of the blend to that of the crude is 1.23. At 100° F., it is 1.83 and at 130° F., 2.27. Each of these six tests was made over a period of one hour at an air mass velocity of .0675 pounds per hour × square feet of crude oil surface.

Variable Air Mass Velocities at 100° F.

In Figure 3 is shown the effect of variable air velocities on the amount of vapor picked up by each cubic foot.

The lower the mass velocity of the air, the better is the approach toward equilibrium conditions. From Figure 3, it is to be observed that the gasoline vapor

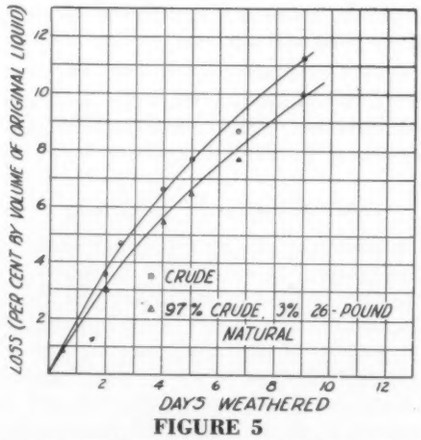


FIGURE 5

Laboratory weathering tests in 1000 cc. cylinders.

picked up by the air is three and a half times as much at a mass velocity of 1.3 pounds per square foot per hour as it is at 6.75 pounds mass velocity. For some unexplainable cause the partial pressure of the gaso-

line vapor reached a maximum of 6.05 pounds per square inch absolute. The value was obtained as follows:

The ratio of gasoline vapor volume to that of air is 0.7 to 1.0 for the highest ratio. Since the partial pressures are proportional to the respective volumes

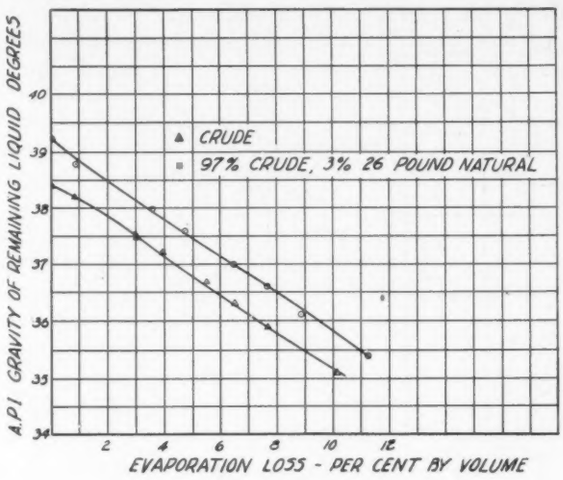


FIGURE 6
Weathering tests in 1000 cc. cylinders.

of each component in the mixture, the partial pressure of the gasoline vapor would be

$$(.7/.7 + 1.0) \times 14.7 = 6.05 \text{ lbs.}$$

The same experimental results as shown in Figure 3 are presented differently in Figure 4.

Weathering Tests

One sample each of the crude and the blend was placed in a graduated cylinder in a room over a nine-day period. The results of this test are shown in Figures 5 to 8 inclusive. It will be observed that the relative loss of gasoline from the blend to that of the crude oil over a two-day period was 1.24; five-day period 1.15; and for nine days 1.125. It is interesting to observe that over this nine-day period the A.P.I. gravity of the gasoline which was lost from the crude oil was 74.4° A.P.I. and from the blend 81.8°.

For every degree loss in A.P.I. gravity of the crude oil, there is an approximate shrinkage of 2½ percent by volume, or slightly over 1.05 gallons of gasoline lost per barrel. Since the molecular weight of this vapor is approximately 72, or that of pentane, there

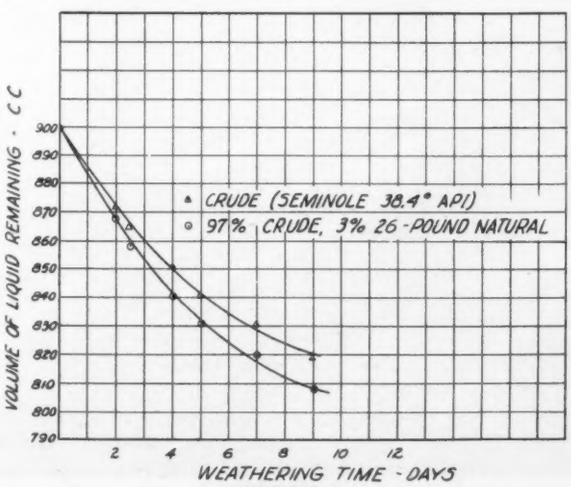


FIGURE 8
Weathering tests in 1000 cc. cylinders.

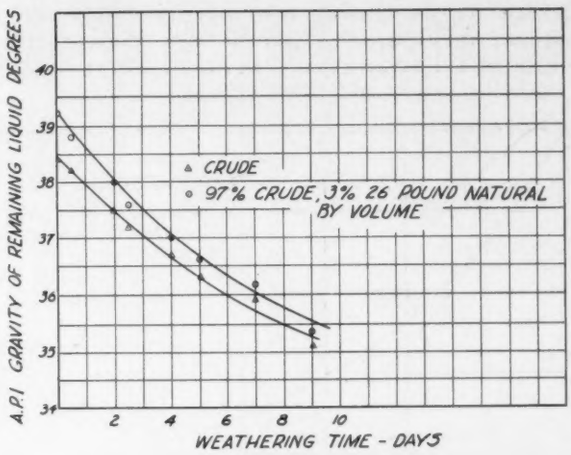


FIGURE 7
Weathering tests in 1000 cc. cylinders.

would be (1.05 × 27.7) or 29 cubic feet of vapor evolved per barrel of crude oil if it was being lowered in gravity one degree. In terms of large quantities, such as 1000 barrels of crude oil, there would be 29,000 cubic feet of vapor evolved during this one-degree drop in gravity; and this vapor in turn could form as much as 2,240,000 standard cubic feet of explosive mixture in air. This latter calculation on the explosive mixture is based on data published by H. F. Coward and G. W. Jones in Bulletin 279, p. 69, United States Bureau of Mines, on the "Limits of Inflammability of Gases and Vapors." The amount of vaporization from a tank would be a function of the physical properties of the oil, its temperature, and

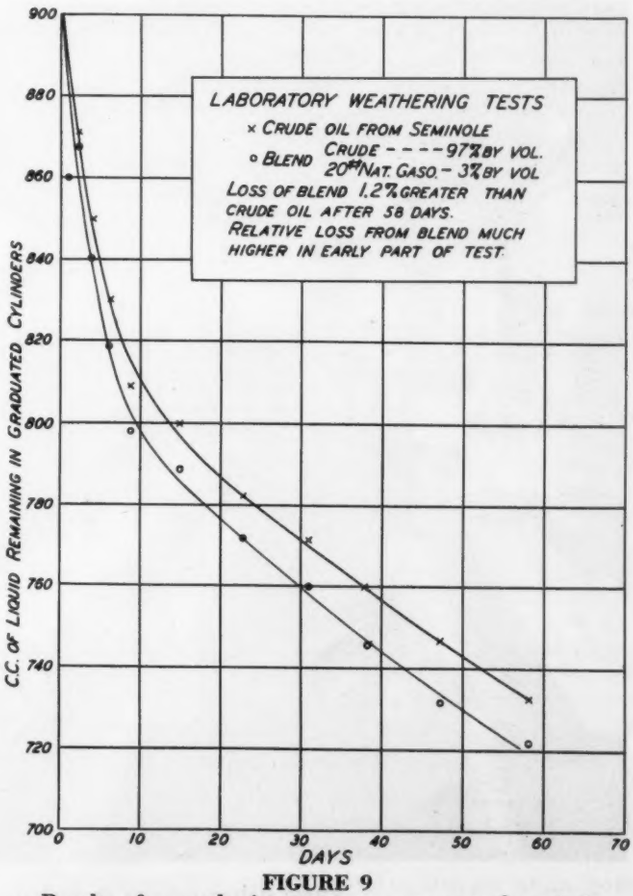


FIGURE 9
Results of a weathering test over a two-month period.

the rate of air circulation over the surface of the oil.

Results for weathering tests over a 58-day period are shown in Figure 9. After 15 days of weathering the rate of evaporation loss is practically the same for both the crude and the blend.

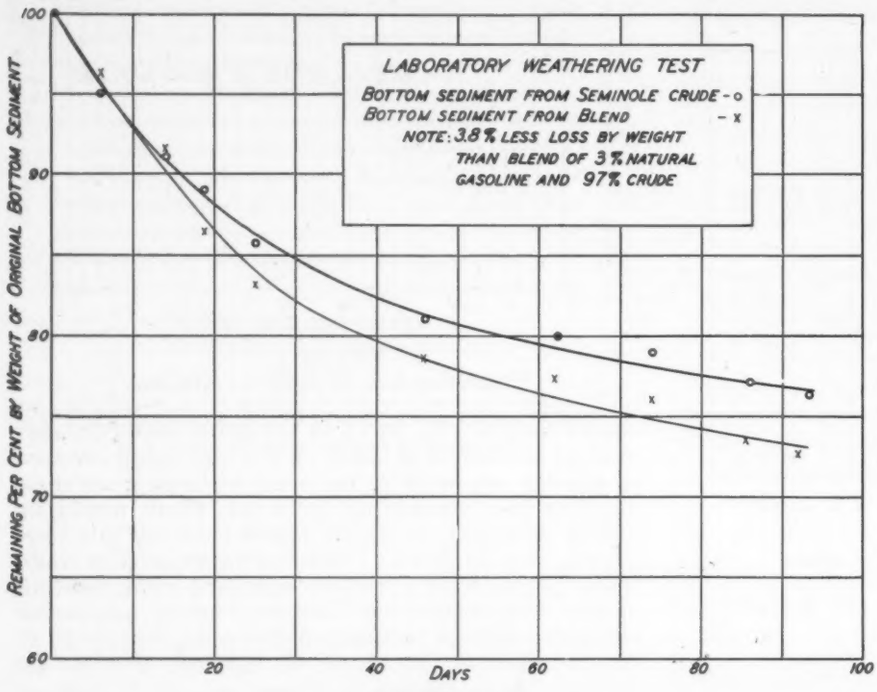


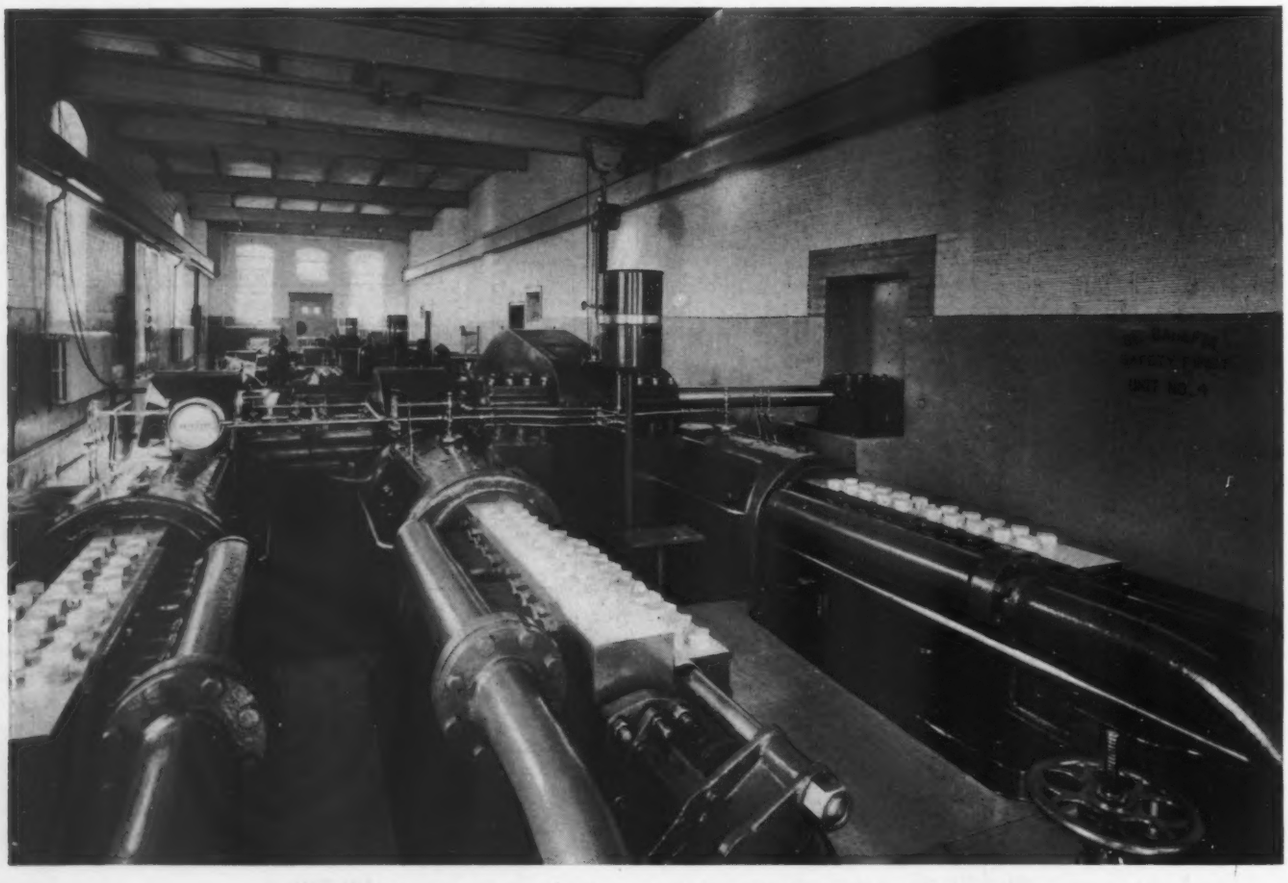
FIGURE 10

Weathering tests on bottom sediment from Seminole crude and crude-gasoline blends

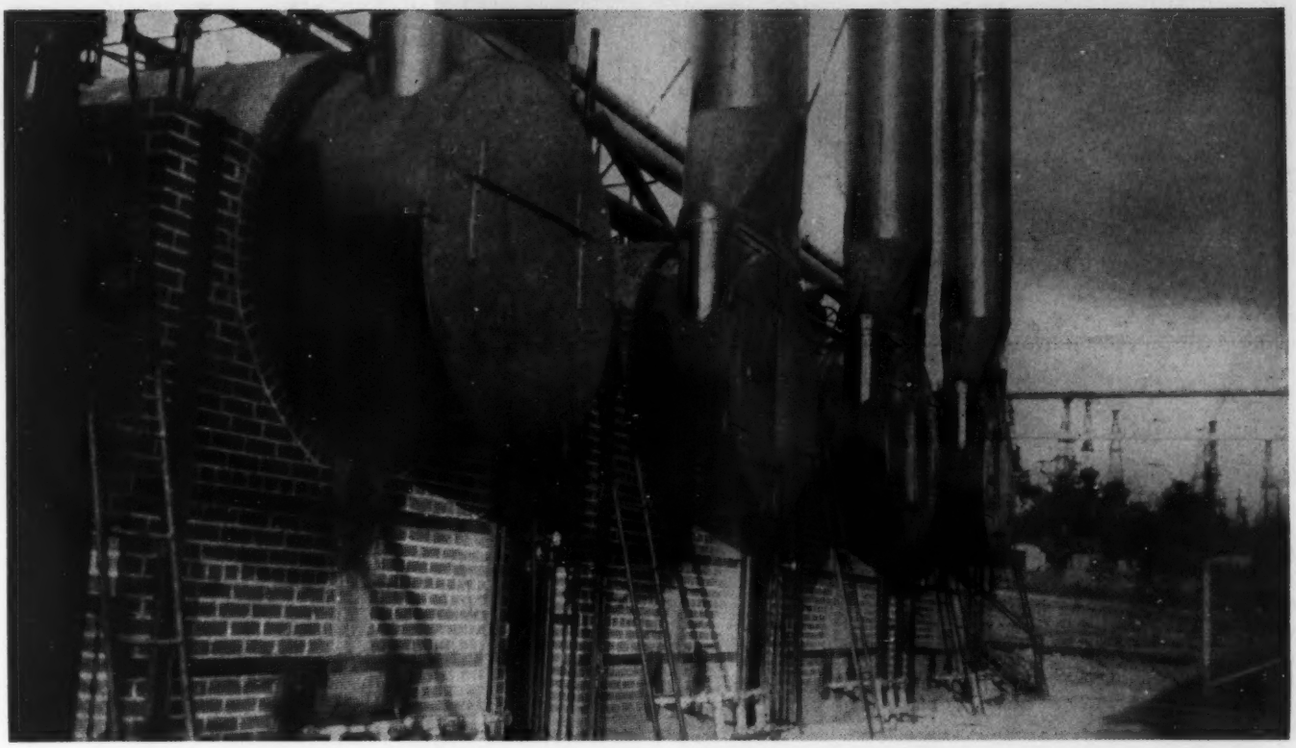
It seems logical that the bottom sediment from the blend of gasoline and crude oil would be more volatile than the settling from crude oil alone. This conclusion is based on the fact that crude oils recovered from bottom sediments are as a rule almost as high in A.P.I. gravity as the original crudes themselves.

The author has received information from a crude-oil reclaiming company which treated tank bottoms near Dublin, Indiana. It was observed on this tank farm that storage tank bottoms, settling from Seminole crude, were far less volatile than bottom sediment from the 3 percent gasoline-crude oil blend. An explosion occurred during the cleaning out of one of the tank bottoms containing the blend, as a result of the ignition of vapor at a distance much farther from the tank than would usually be considered hazardous.

The experimental laboratory data on the weathering of bottom sediments originating from the Seminole crude and blend, as presented in Figure 10, show that the settling from the blend lost 3.8 percent more by weight over a 92-day period than the sediment from the crude.



Pump station interior in modern pipe line transportation system.



Individual ladders are a safety adjunct for the boilers in their new setting

New Setting and Revamped Hookup for a Boiler Battery

WHEN lessened activity in the Long Beach oil field provided space for moving its battery of gasoline plant boilers to a more favorable location, Gilmore-Dabney Gasoline Company redesigned foundations, piping and accessories to provide more efficient operation and promote safety. The new location is higher than the plant yard and farther from the processing equipment than the former location. A warehouse and field office are between the boilers and the plant.

Since the boilers are supported by trusses at each end, it was possible to make excavations and pour the foundations before the boilers were moved. When the concrete was run, an apron covering the area was provided so the location can be more easily kept clean.

Fuel lines were laid before the concrete was poured. Each unit is equipped with three burners, each controlled with a globe valve, so any one burner can be removed without disturbing the others.

After each boiler was suspended on the trusses, the brick setting was completed with an inspection door at the rear and a peep-hole beneath the smoke box above the burner setting. The target is placed so the flame impinges at the desired angle for the heat to spread evenly across and around the exposed sheet of the boiler and continue so the radiant heat passes through the tubes without channeling. Each burner opening has a blanking-off door so when one is removed the opening can be closed to control the draft.

Automatic water-level controllers are attached to each boiler and in addition, a high- and low-level instrument which signals when the water is low or high. So the fireman may inspect these instruments without difficulty, each boiler is equipped with an individual ladder, made of pipe and steel bars, with the side rails forming a hook which passes over one of the supporting sections of the trusses supporting the boilers.

The battery is equipped with a double steam header, both connected to the same riser on each boiler with adequate control gates and valves. Across the battery is a safety walk with hand rails which is reached by mounting a stairway at one end of the setting. Branching from the walkway are five short walks running at right angles to the main walk so the operator has easy access to the safety valves and controls on the steam headers.

The non-return valves are angle-type units with

Blow down lines converge in one accumulator. The complete hookup is inclosed for safety of employes as well as the public.

side openings leading to the headers which run across the setting from one side to the other. To support these headers and remove unnecessary strain on fittings, an adjustment jack with a broad plate for footing rests upon the insulation on top of the boilers. The riser of the jack is made of pipe with a nut welded to the upper end through which a one-inch threaded rod is passed, having a hexagon head resting against the steam header connections.

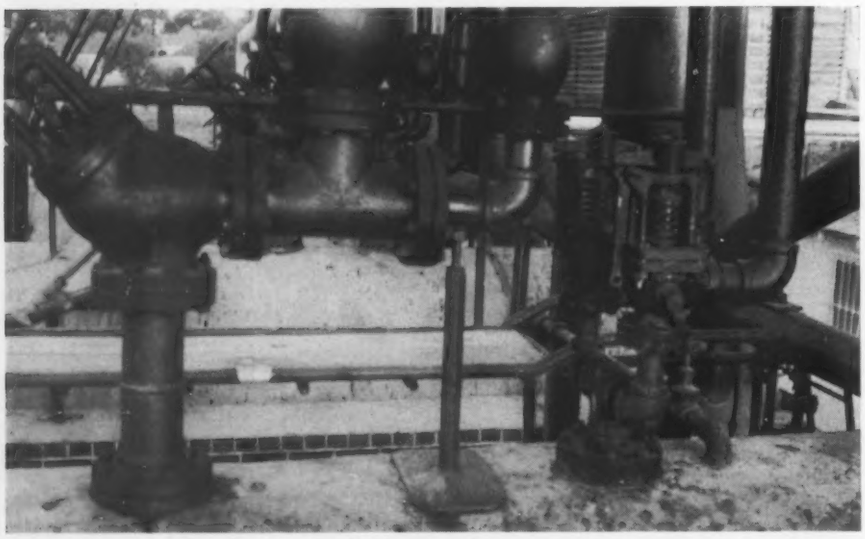
Blow-down connections were provided at the end opposite the burners with an extra heavy pipe passing through the brick setting. Adequate blow-down valves are attached to this pipe which continues outward with a long sweeping bend leading to a blow-down receiver. This vessel is half buried and the piping attached at one end near the top. Each line is on concrete piers without tying down so that they may expand.

The blow-down vessel serves two purposes; the first when normal blow-down is accomplished, and the second to receive the boiler water when one is cut out of service to be cleaned.

It has two outlet connections opposite from the blow-down line. One consists of 6-inch which extends to the lower inside of the vessel, and is submerged at the lower end with the accumulation of water, and the other attached to the sheet of the blow-down receiver and equipped with a back-pressure valve set at approximately 1½ pounds. When steam only is released from the blow-down receiver, it passes through the back-pressure valve without allowing an appreciable quantity of the water to escape, but, as the pressure increases, because of a greater amount of blow-down, water and steam both are carried from the vessel.

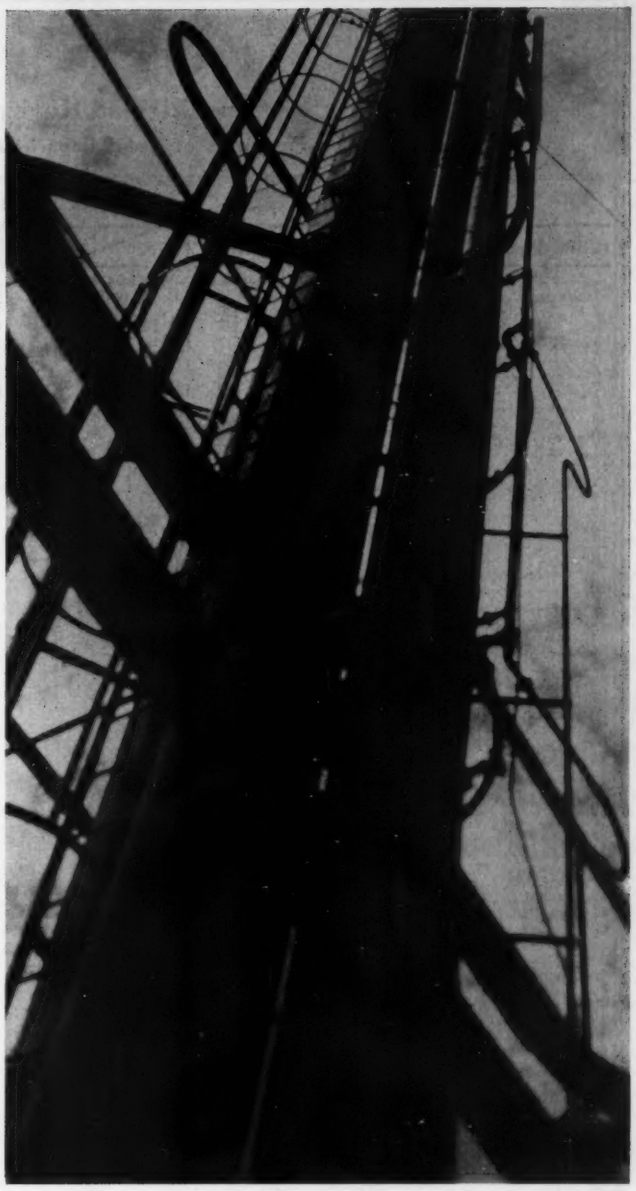
To evacuate the water from the receiver, a live steam line was connected to a small dome-like connection at the blow-down connection end, so that, when required, all the fluid in the receiver at the time can be blown out through the submerged 6-inch line. Condensate resulting from steam passing through a long pipe is permitted to flow into the plant water-cooling pit, while water as such, containing the dissolved salts and sludge from the boiler goes to the sewer.

Fuel obtained from plant residue gas is controlled by two reducing valves by the pressure of the steam in the headers. With automatic water-level controllers and high- and low-level whistles, the operation of this battery has been greatly simplified The attention required consists merely of an occasional trip by the operator to check the performance of the automatic equipment, and to blow-down each boiler at stated periods.



Weight of the steam header rests on an adjustable jack.

Double Gasoline Stream Improves Octane Rating



ONE of the smaller Illinois refineries which is being expanded is Cascade Refining Company plant at Salem. This plant began operating in the spring of 1940 with a crude capacity of 3000 barrels, to operate as a skimming plant until the cracking plant could be finished.

Operation of this plant differs from most topping plants in that two streams of gasoline are removed from the charge, one by exchanger heat and the other in a conventional tube still. The reason for separate streams of gasoline is that, when the two are distilled separately and blended, the combination has a higher octane rating than the same gasoline would have if the entire range of motor fuel were removed from a common fractionating column and condensed as a single stream.

The crude is picked up with reciprocating steam pumps and charged at a pressure of 18 pounds to topped crude and gas/oil exchangers where a temperature of 325° F. is obtained when the crude is flashed into a primary column, 4 feet by 25 feet, containing three bubble plates located near the top head. The vapor line is not connected with the main fractionating column, but leads directly to atmospheric condensers. The quantity and quality of the distillate taken from this column is in direct relation to the pressure and temperature, and no reflux is pumped back to control the end point or boiling range of the product. This gasoline is pumped to working storage from the receiver to be blended immediately with the succeeding gasoline product.

The remainder of the crude charge is pumped from the base of the primary flash column and delivered at a pressure of 20 pounds to a tube still, the transfer temperature of which is maintained at 680° F., and passed to the main fractionating column. This tower is 4 feet in diameter and 68 feet high and contains 25 bubble plates. Gasoline is taken from the top outlet connection at a temperature of 320° F., which is controlled by pumping back to the top of the column sufficient condensate to maintain the temperature.

Beside the gasoline, three side cuts are taken from the tower; kerosene, distillate and gas oil. The fuel, or topped crude is removed from the base of the column and will be used as a charging stock for the cracking plant soon to be in operation. The kerosene is taken from the side of the column and received by a side stripper to control the specifications of the completed product. Distillate and gas/oil are removed from lower take-off connections and cooled and pumped to storage without further processing.

The three columns are grouped near each other and are insulated to retain and maintain the heat of the process without interference by outside influences. The gasoline is doctor treated, after blending the two streams. It has been observed that, if the two streams are removed separate in the above manner, condensed and cooled prior to immediate blending in direct proportion to the quantity of their manufacture, the overall quality of the finished gasoline will be superior to one manufactured as a single stream taken from the top of the main fractionating column. And this method is being carried out, prior to treating to remove and convert the sulfur compounds.

The various products have the following percentages and gravities.

PRODUCT	A.P.I. Gravity	Boiling Range	Barrels	Percent
Light Gasoline	70/72°	80-274 °F.	360	12
Heavy Gasoline	58°	98-400 °F.	630	21
Kerosene	42°	525 °F. EP.	360	12
Distillate	38°	600 °F. EP.	120	4
Gas Oil	34°	90 % over 680 °F.	360	12
Fuel Oil	21°	210 flash	1,110	37
Gas and Loss	....	.....	60	2
Total	....	.....	3,000	100

Capacities of Horizontal Cylindrical Tanks

Per Cents of Total Capacities for Diameters from 48″ to 68″

DIAMETERS IN INCHES

Depth, Inches	48″	50″	52″	54″	56″	58″	60″	62″	64″	66″	68″
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
1	0.51	0.48	0.44	0.42	0.40	0.38	0.37	0.35	0.33	0.32	0.30
2	1.43	1.34	1.26	1.19	1.12	1.08	1.02	0.98	0.93	0.89	0.85
3	2.6	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.6
4	4.0	3.7	3.5	3.3	3.2	3.0	2.9	2.7	2.6	2.5	2.4
5	5.5	5.2	4.9	4.6	4.4	4.2	4.0	3.8	3.6	3.5	3.3
6	7.2	6.8	6.4	6.1	5.8	5.5	5.2	5.0	4.7	4.5	4.3
7	9.0	8.5	8.1	7.6	7.2	6.9	6.6	6.2	5.9	5.7	5.4
8	11.0	10.3	9.8	9.2	8.8	8.4	7.9	7.6	7.2	6.9	6.6
9	13.0	12.2	11.6	11.0	10.4	9.9	9.4	9.0	8.6	8.2	7.8
10	15.1	14.2	13.4	12.8	12.1	11.5	11.0	10.5	10.0	9.5	9.1
11	17.2	16.3	15.4	14.6	13.9	13.2	12.5	12.0	11.5	10.9	10.5
12	19.5	18.5	17.5	16.5	15.7	14.9	14.2	13.6	13.0	12.4	11.9
13	21.9	20.7	19.5	18.5	17.6	16.7	16.0	15.2	14.6	13.9	13.3
14	24.3	22.9	21.7	20.6	19.5	18.6	17.7	16.9	16.2	15.5	14.8
15	26.7	25.2	24.0	22.7	21.5	20.5	19.6	18.7	17.8	17.1	16.4
16	29.3	27.6	26.2	24.8	23.6	22.4	21.4	20.5	19.5	18.7	18.0
17	31.7	30.0	28.4	27.0	25.7	24.4	23.3	22.3	21.3	20.4	19.5
18	34.2	32.4	30.7	29.2	27.8	26.4	25.2	24.1	23.1	22.1	21.2
19	36.8	34.9	33.0	31.4	29.9	28.5	27.2	26.0	24.9	23.8	22.8
20	39.4	37.3	35.5	33.7	32.1	30.6	29.1	27.9	26.7	25.6	24.5
21	42.0	39.9	37.8	36.0	34.2	32.7	31.2	29.8	28.5	27.4	26.3
22	44.7	42.4	40.2	38.3	36.4	34.8	33.3	31.8	30.4	29.2	28.0
23	47.3	44.9	42.6	40.6	38.7	36.9	35.3	33.8	32.3	31.0	29.8
24	50.0	47.4	45.2	42.9	40.9	39.1	37.4	35.7	34.3	32.8	31.5
25	52.7	50.0	47.6	45.3	43.2	41.2	39.5	37.7	36.2	34.7	33.3
26	55.3	52.6	50.0	47.6	45.4	43.4	41.5	39.8	38.1	36.6	35.1
27	58.0	55.1	52.4	50.0	47.7	45.6	43.7	41.8	40.1	38.5	37.0
28	60.6	57.6	54.8	52.4	50.0	47.8	45.8	43.8	42.1	40.4	38.8
29	63.2	60.1	57.4	54.7	52.3	50.0	47.8	45.9	44.0	42.3	40.7
30	65.8	62.7	59.8	57.1	54.6	52.2	50.0	47.9	46.0	44.2	42.5
31	68.3	65.1	62.2	59.4	56.8	54.4	52.2	50.0	48.0	46.1	44.4
32	70.8	67.6	64.5	61.7	59.1	56.6	54.2	52.1	50.0	48.0	46.2
33	73.3	70.0	67.0	64.0	61.3	58.8	56.3	54.1	52.0	50.0	48.1
34	75.7	72.4	69.3	66.3	63.6	60.9	58.5	56.2	54.0	52.0	50.0
35	78.1	74.8	71.6	68.6	65.8	63.1	60.5	58.2	56.0	53.9	51.9
36	80.5	77.1	73.8	70.8	67.9	65.2	62.6	60.2	57.9	55.8	53.8
37	82.8	79.3	76.0	73.0	70.1	67.3	64.7	62.3	59.9	57.7	55.6
38	84.9	81.5	78.3	75.2	72.2	69.4	66.7	64.3	61.9	59.6	57.5
39	87.0	83.7	80.5	77.3	74.3	71.5	68.8	66.2	63.8	61.5	59.3
40	89.0	85.8	82.5	79.4	76.4	73.6	70.9	68.2	65.7	63.4	61.2
41	91.0	87.8	84.6	81.5	78.5	75.6	72.8	70.2	67.7	65.3	63.0
42	92.8	89.7	86.6	83.5	80.5	77.6	74.8	72.1	69.6	67.2	64.9
43	94.5	91.5	88.4	85.4	82.4	79.5	76.7	74.0	71.5	69.0	66.7
44	96.0	93.2	90.2	87.2	84.3	81.4	78.6	75.9	73.3	70.8	68.5
45	97.4	94.8	91.9	89.0	86.1	83.3	80.4	77.7	75.1	72.6	70.2
46	98.6	96.3	93.6	90.8	87.9	85.1	82.3	79.5	76.9	74.4	72.0
47	99.5	97.6	95.1	92.4	89.6	86.8	84.0	81.3	78.7	76.2	73.7
48	100.0	98.7	96.5	93.9	91.2	88.5	85.8	83.1	80.5	77.9	75.5
49	.....	99.5	97.7	95.4	92.8	90.1	87.5	84.8	82.2	79.6	77.2
50	.....	100.0	98.7	96.7	94.2	91.6	89.0	86.4	83.8	81.3	78.8
51	.....	.....	99.6	97.8	95.6	93.1	90.6	88.0	85.4	82.9	80.5
52	.....	.....	100.0	98.8	96.8	94.5	92.1	89.5	87.0	84.5	82.0
53	.....	.....	.....	99.6	97.9	95.8	93.4	91.0	88.5	86.1	83.6
54	.....	.....	.....	100.0	98.9	97.0	94.8	92.4	90.0	87.6	85.2
55	.....	.....	.....	.....	99.6	98.0	96.0	93.8	91.4	89.1	86.7
56	.....	.....	.....	.....	100.0	98.9	97.1	95.0	92.8	90.5	88.1
57	.....	.....	.....	.....	.....	99.6	98.1	96.2	94.1	91.8	89.5
58	.....	.....	.....	.....	.....	100.0	99.0	97.3	95.3	93.1	90.9
59	.....	.....	.....	.....	.....	.....	99.6	98.2	96.4	94.3	92.2
60	.....	.....	.....	.....	.....	.....	100.0	99.0	97.4	95.5	93.4
61	.....	.....	.....	.....	.....	.....	.....	99.6	98.3	96.5	94.6
62	.....	.....	.....	.....	.....	.....	.....	100.0	99.1	97.5	95.7
63	.....	.....	.....	.....	.....	.....	.....	.....	99.7	98.4	96.7
64	.....	.....	.....	.....	.....	.....	.....	.....	100.0	99.1	97.6
65	.....	.....	.....	.....	.....	.....	.....	.....	.....	99.7	98.4
66	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.0	99.1
67	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	99.7
68	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.0
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Example: Given a horizontal cylindrical tank 68 inches in diameter and 52 feet long and containing 17 inches of liquid, it is desired to know the volume occupied by the liquid.

First determine the total volume of the tank. Reading across the top horizontal column under "Diameter in Inches," locate 68″—the diameter of the tank. Following vertically downward to the bottom of the column, it will be found that the capacity per foot of length of a 68″ tank is 25.2 cubic feet.

Since the tank is 32 feet long, its total volume is 32 x 25.2=806.4 cubic feet.

Locating the depth of liquid, 17″, in the vertical column on the extreme left entitled "Depth Inches," and reading horizontally to the right until column 68″ is reached, it will be found that 17″ represents 19.5 percent of the total volume of this tank.

Therefore, the volume occupied by the liquid is:

806.4 x .195=157.2 cubic feet.

CAPACITIES IN CUBIC FEET PER ONE FOOT OF LENGTH

	12.6	13.6	14.7	15.9	17.1	18.3	19.6	21.0	22.3	23.8	25.2

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Capacities of Horizontal Cylindrical Tanks

Per Cents of Total Capacities for Diameters from 70″ to 84″

Depth, Inches	DIAMETER IN INCHES									
	70″	72″	73″	74″	75″	76″	78″	80″	82″	84″
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
1	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.23	0.23	0.22
2	0.81	0.78	0.76	0.75	0.73	0.72	0.69	0.67	0.64	0.62
3	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.1
4	2.3	2.2	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.7
5	3.2	3.0	3.0	2.9	2.9	2.8	2.7	2.6	2.5	2.4
6	4.1	3.9	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2
7	5.2	5.0	4.9	4.8	4.7	4.6	4.4	4.3	4.1	4.0
8	6.3	6.0	6.0	5.8	5.7	5.6	5.4	5.2	5.0	4.9
9	7.5	7.2	7.1	6.9	6.8	6.7	6.4	6.2	6.0	5.8
10	8.8	8.4	8.2	8.1	7.9	7.8	7.5	7.2	7.0	6.7
11	10.1	9.7	9.4	9.3	9.1	8.9	8.6	8.3	8.0	7.7
12	11.4	11.0	10.7	10.5	10.3	10.1	9.8	9.4	9.1	8.7
13	12.8	12.3	12.1	11.8	11.6	11.4	11.0	10.6	10.2	9.8
14	14.2	13.6	13.5	13.1	12.9	12.7	12.2	11.8	11.3	11.0
15	15.7	15.0	14.8	14.5	14.2	14.0	13.5	13.0	12.5	12.2
16	17.2	16.5	16.2	15.9	15.6	15.4	14.8	14.2	13.7	13.3
17	18.8	18.1	17.7	17.4	17.1	16.7	16.1	15.5	15.0	14.5
18	20.3	19.6	19.2	18.8	18.5	18.1	17.5	16.8	16.3	15.7
19	21.9	21.1	20.7	20.3	19.9	19.5	18.8	18.2	17.6	17.0
20	23.6	22.7	22.3	21.8	21.5	21.0	20.2	19.6	18.9	18.2
21	25.2	24.3	23.8	23.4	22.9	22.5	21.7	21.0	20.2	19.5
22	26.9	26.0	25.4	24.9	24.4	24.0	23.2	22.4	21.6	20.7
23	28.6	27.5	27.0	26.5	26.0	25.5	24.6	23.8	23.0	22.2
24	30.3	29.1	28.6	28.1	27.6	27.1	26.1	25.2	24.4	23.6
25	32.0	30.8	30.3	29.7	29.1	28.6	27.6	26.7	25.8	25.0
26	33.8	32.5	31.9	31.4	30.8	30.2	29.2	28.2	27.2	26.3
27	35.6	34.2	33.6	33.0	32.4	31.8	30.7	29.7	28.7	27.7
28	37.4	36.0	35.3	34.7	34.0	33.4	32.3	31.2	30.2	29.1
29	39.1	37.7	37.0	36.3	35.7	35.1	33.9	32.7	31.6	30.6
30	40.9	39.5	38.7	38.0	37.3	36.7	35.4	34.3	33.1	32.0
31	42.7	41.2	40.4	39.7	39.0	38.3	37.0	35.9	34.6	33.5
32	44.5	42.9	42.2	41.4	40.7	39.9	38.6	37.4	36.1	35.0
33	46.4	44.7	43.9	43.1	42.4	41.6	40.2	38.9	37.6	36.5
34	48.2	46.4	45.6	44.8	44.0	43.3	41.9	40.5	39.2	37.9
35	50.0	48.2	47.4	46.5	45.8	45.0	43.5	42.0	40.7	39.4
36	51.8	50.0	49.1	48.2	47.4	46.6	45.1	43.6	42.2	40.9
37	53.6	51.8	50.9	50.0	49.1	48.3	46.7	45.2	45.8	42.4
38	55.5	53.6	52.6	51.8	50.9	50.0	48.3	46.8	45.4	43.9
39	57.3	55.3	54.4	53.5	52.6	51.7	50.0	48.4	46.9	45.4
40	59.1	57.1	56.1	55.2	54.2	53.4	51.7	50.0	48.4	47.0
41	60.9	58.8	57.8	56.9	56.0	55.0	53.3	51.6	50.0	48.5
42	62.6	60.5	59.6	58.6	57.6	56.7	54.9	53.2	51.6	50.0
43	64.4	62.3	61.3	60.3	59.3	58.4	56.5	54.8	53.1	51.5
44	66.2	64.0	63.0	62.0	61.0	60.1	58.1	56.4	54.6	53.0
45	68.0	65.8	64.7	63.7	62.7	61.7	59.8	58.0	56.2	54.6
46	69.7	67.5	66.4	65.3	64.3	63.3	61.4	59.5	57.8	56.1
47	71.4	69.2	68.1	67.0	66.0	64.9	63.0	61.1	59.3	57.6
48	73.1	70.9	69.7	68.6	67.6	66.6	64.6	62.6	60.8	59.1
49	74.8	72.5	71.4	70.3	69.2	68.2	66.1	64.1	62.4	60.6
50	76.4	74.0	73.0	71.9	70.9	69.8	67.7	65.7	63.9	62.1
51	78.1	75.7	74.6	73.5	72.4	71.4	69.3	67.3	65.4	63.5
52	79.7	77.3	76.2	75.1	74.0	72.9	70.8	68.8	66.9	65.0
53	81.2	78.9	77.7	76.6	75.6	74.5	72.4	70.3	68.4	66.5
54	82.8	80.4	79.3	78.2	77.1	76.0	73.9	71.8	69.8	68.0
55	84.3	81.9	80.8	79.7	78.5	77.5	75.4	73.3	71.3	69.4
56	85.8	83.5	82.3	81.2	80.1	79.0	76.8	74.8	72.8	70.9
57	87.2	85.0	83.8	82.6	81.5	80.5	78.3	76.2	74.2	72.3
58	88.6	86.4	85.2	84.1	82.9	81.9	79.8	77.6	75.6	73.7
59	89.9	87.7	86.5	85.5	84.4	83.3	81.2	79.0	77.0	75.0
60	91.2	89.0	87.9	86.9	85.8	84.6	82.5	80.4	78.4	76.4
61	92.5	90.3	89.3	88.2	87.1	86.0	83.9	81.8	79.8	77.8
62	93.7	91.6	90.6	89.5	88.4	87.3	85.2	83.2	81.1	79.3
63	94.8	92.8	91.8	90.7	89.7	88.6	86.5	84.5	82.4	80.5
64	95.9	94.0	92.9	91.9	90.9	89.9	87.8	85.8	83.7	81.8
65	96.8	95.0	94.0	93.1	92.1	91.1	89.0	87.0	85.0	83.0
66	97.7	96.1	95.1	94.2	93.2	92.2	90.2	88.2	86.3	84.3
67	98.5	97.0	96.1	95.2	94.3	93.3	91.4	89.4	87.5	85.5
68	99.2	97.8	97.0	96.2	95.3	94.4	92.5	90.6	88.7	86.7
69	99.7	98.6	97.9	97.1	96.3	95.4	93.6	91.7	89.8	87.8
70	100.0	99.2	98.6	97.9	97.1	96.4	94.6	92.8	90.9	89.0
71	....	99.7	99.2	98.6	98.0	97.2	95.6	93.8	92.0	90.2
72	....	100.0	99.7	99.2	98.7	98.0	96.5	94.8	93.0	91.3
73	....	....	100.0	99.7	99.3	98.7	97.3	95.7	94.0	92.3
74	....	....	....	100.0	99.7	99.3	98.1	96.6	95.0	93.3
75	....	....	....	....	100.0	99.7	98.7	97.4	95.9	94.2
76	....	....	....	....	....	100.0	99.3	98.1	96.7	95.1
77	....	....	....	....	....	....	99.8	98.8	97.5	96.0
78	....	....	....	....	....	....	100.0	99.3	98.2	96.8
79	....	....	....	....	....	....	....	99.8	98.8	97.6
80	....	....	....	....	....	....	....	100.0	99.4	98.3
81	....	....	....	....	....	....	....	....	99.8	98.9
82	....	....	....	....	....	....	....	....	100.0	99.4
83	....	....	....	....	....	....	....	....	....	99.8
84	....	....	....	....	....	....	....	....	....	100.0
	CAPACITIES IN CUBIC FEET PER ONE FOOT OF LENGTH									
	26.7	28.3	29.0	29.9	30.6	31.5	33.2	34.9	36.7	38.5

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Dye and Inhibitor Mixer

B. G. ADAMS
Chief Chemist, El Tejon Oil & Refining Corporation

BEFORE installation of the dye and inhibitor mixer, here described and illustrated, we had difficulty in getting all of the dye added to gasoline to go into solution. Although the dye was of grade almost 100 percent soluble and the prescribed two grams to each 100 gallons of gasoline was introduced, samples submitted to the laboratory of Ethyl Gasoline Corporation repeatedly were found to be only 70 to 80 percent of the required color.

The mixer we are now using has proven satisfactory.

It was installed as a by-pass around a valve on the 3-inch line from the discharge of the circulating pump. The 1-inch line to and from the mixer has gate valves at both the inlet and outlet.

In operation the bull plug at the top is removed and the dye introduced through a funnel inserted in the collar. Then the bull plug is replaced.

The main line valve is closed sufficiently to cause a pressure against the pump, then the two valves at the mixer are opened to permit part of the stream to go through the mixer. The baffle at the inlet directs the stream across the bottom where the dye has settled. This washes the dye up and through the 60-mesh screen. The screen, because of its inverted position, never clogs. Operation shows that 20 minutes is sufficient to dissolve 2000 grams of dye.

A. ¼-inch steel plate with ⅜-inch perforations, welded to:

G. A piece of 4-inch pipe, 4 inches long,

B. ¼-inch mesh placed next to A,

C. 16-mesh placed next to B,

D. 6-mesh placed next to C.

E. Ring of same material as A and placed next to D. Bolts are then inserted through A, B, C, D, and E, binding them together.

H. Deflection to direct flow from,

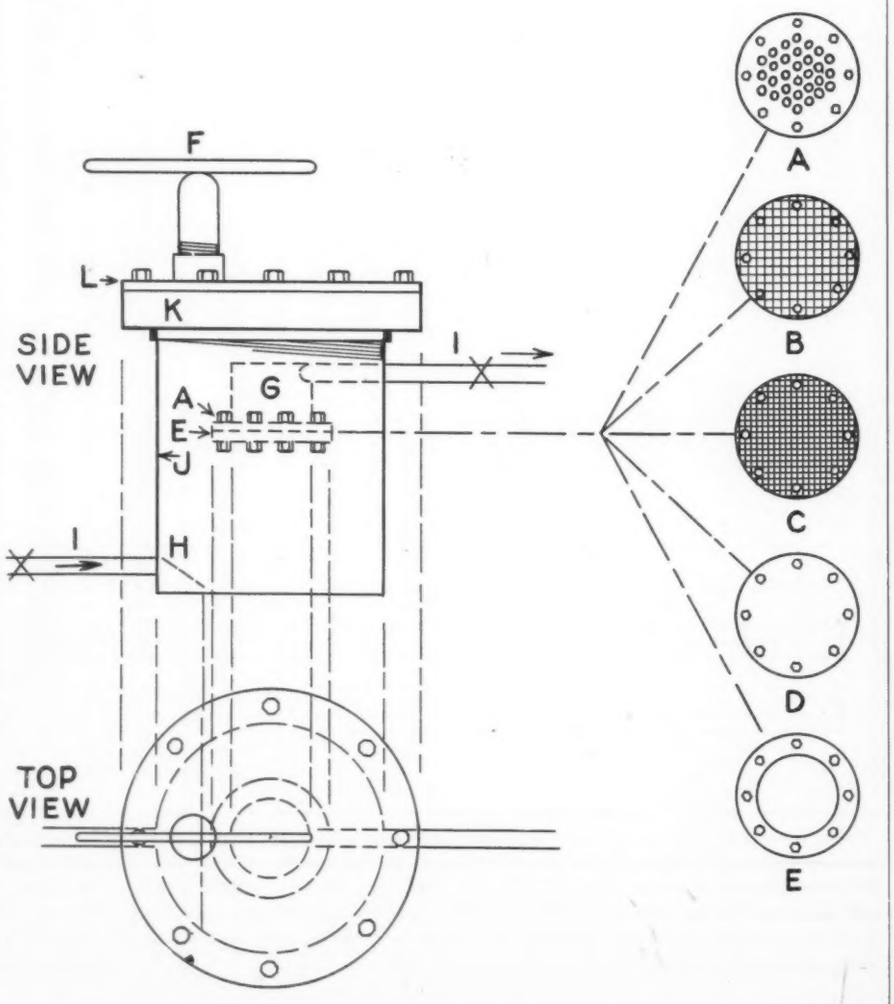
I. A 1-inch pipe to the bottom of pot,

J. A 12-inch casing 12 inches long with bottom welded in and top threaded, to which the flange,

K. Is screwed.

F. Steel rod 1 x 16 inches welded to 3-inch bull plug which fits into the collar welded to,

L. A 1¼-inch steel plate bolted to K.



PENBERTHY PRODUCTS

Reflex

DROP FORGED STEEL LIQUID LEVEL GAGE

EMPTY SPACE SHOWS **WHITE** | LIQUID SHOWS **BLACK**

* * *

Transparent

DROP FORGED STEEL LIQUID LEVEL GAGE

USED TO OBSERVE COLOR AND DENSITY OF LIQUIDS UNDER HIGH PRESSURES, AND/OR TEMPERATURES

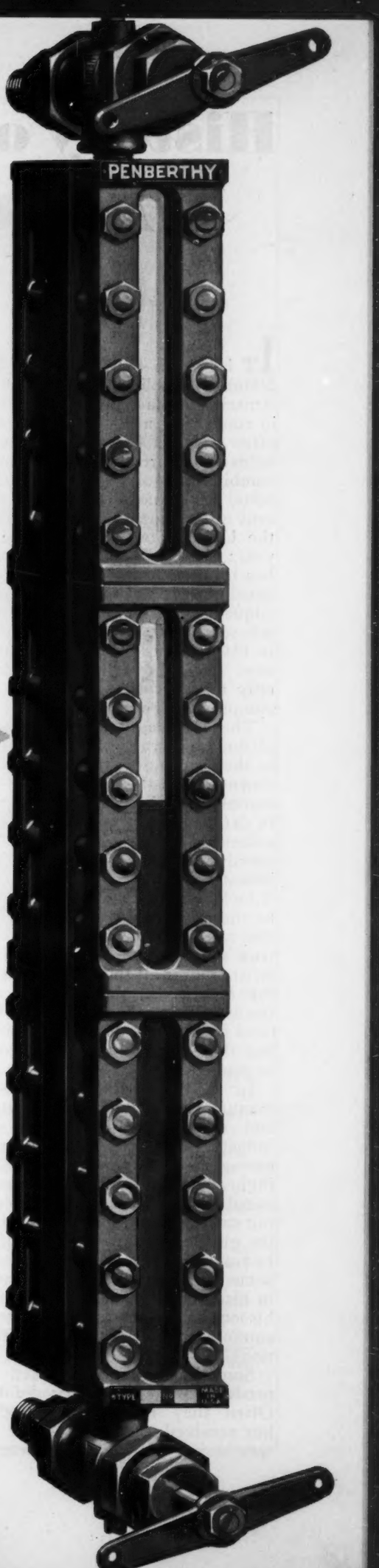
These gages are made of alloy temperature resisting steel and are of the highest quality throughout. Liquid chamber (both single and multiple section) is made from a solid block of steel to assure perfect alignment and rigidity. Frame has extra heavy beam at each end and glass chamber is accurately machined to contour of glass providing full metal backing for gaskets. Gage valves are drop forged steel with stainless trim.

These gages are available in any length and for various pressures and temperatures. All Penberthy gages conform with A. P. I.—A. S. M. E. requirements.

PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN

Canadian Plant: WINDSOR, ONTARIO



History of the Natural Gasoline Association of America

IT has been the function of the Natural Gasoline Association of America to play the dominant role in converting a heterogeneous and often undesirable product of the oil fields into a restricted and stable combination of liquid hydrocarbons, which now comprise 7 percent of the motor fuel consumed in the United States. Within the 20 years that define its activities, it has been its privilege to guide the development of a companion Liquefied Petroleum Gas industry, whose 300,000,000 gallon sales total in 1940, an increase of 32.5 percent over 1939, should be accepted as only an indication of future consumption magnitude.

There are scores of other accomplishments wrapped in the history of the association. To set them all down would be a burden to a chronicle, while giving the progress in detailed steps would result in a volume which might be filed but certainly would not be read. The industry is still moving along and it looks like the next 20 years will be the most fruitful. Consequently this can not be called history in its true sense, for history should be written after all the facts are in. In the case of natural gasoline and the association that fosters it, a few facts have been put into the record but the search for facts has only begun.

In the sense that there were manufacturing plants, plant output and sales, there was such an industry prior to 1921. They were casinghead plants, which made casinghead gasoline. The words designated what resulted from processing casinghead gas and weathering the output. The plant owner, if he had a laboratory, could determine some specifications on what he had in his tanks but he never operated his equipment to the objective of coming to predetermined specifications.

Sometimes refiners wanted the product; sometimes they did not. Often they bought one product but received another, because the weathering process had a way of continuing while tank cars were rolling. Consequently some refiners adopted the practice of sending partly filled cars with refinery output and filling with casinghead at its place of manufacture. As the car rolled to its destination, blending was accomplished.

A Long Ride

That practice pleased railroad officials, who were as chary of raw casinghead gasoline as they were of TNT. Some explosions had left marks about rail terminals. This attitude has been well set forth by W. K. Warren in the following paragraph from his paper, "The Marketing of Natural Gasoline," read before the ninth annual convention of the association:

"One of the larger manufacturers of this period was Douglas W. Fanchot, now deceased, and when he began to ship casinghead in the raw state (not blended) the railroads were skeptical of its nature and thought of it as liquid dynamite, hazardous to both life and property. To convince them otherwise Mr. Fanchot bargained with the Frisco railroad that if they would accept the shipment he would ride a tank car loaded with casinghead from his plant at Kiefer, Oklahoma, to its destination at Neodesha, Kansas, and according to Mr. Fanchot's own words he was in doubt about his safe arrival in Neodesha. However, he arrived safely and since that time there has been little difficulty in shipping casinghead, now better known as natural gasoline."

What the industry was making has been set forth aptly by H. T. Ashton, who summarized the growth of the association at the annual meeting in 1936:

"Even in 1921 a check of the Mid-Continent area revealed that there were over 100 different grades of raw casinghead gasoline and blends being manufactured. This was an impossible situation and the association went to work to unsnarl this tangled mass of products."

That was where the Association of Casinghead Gasoline Manufacturers came in, April 21, 1921. Shortly thereafter the name was changed to the Association of Natural Gasoline Manufacturers. In 1926, after dissolution of the Natural Gas Association of America, the present name, Natural Gasoline Association of America, was adopted. This name had been desired earlier but possibility of confusion prevented its selection.

The remarks of W. M. Welch, the first president, so well covered the need of the industry as well as the course of the association that it is little short of the theme of its history:

Specifications First

"We believed that the greatest good would be accomplished by commencing at and with the internal and intrinsic problems of our industry. We felt that if we set our house in order the satisfactory solution of the external or marketing problems would follow and that our commodity would logically and naturally take its true position in the price scale of petroleum problems. Instead of playing with the price situation, which was threatening to consume us, we tried to make our structure fireproof."

One of the first accomplishments of the association was adoption of a set of specifications. For the first time the natural gasoline manufacturer proposed to offer a product of known qualities, while for the first time the buyer had opportunity to designate what he wanted under the assurance that he could get it.

Specifications have been perhaps the outstanding contribution of the association. The work of the several committees has had influence on the manufacture of natural gasoline and in addition contributed much to the refining industry, the automobile industry and to the public. Progress and effectiveness of the association is in no wise better proven than the record of changes in specifications for natural gasoline. The first set of specifi-

THE Hanlon Award is an honor bestowed each year on some individual who has made outstanding contribution to the natural gasoline industry. Names now engraved on the plaque are: R. C. Alden, Phillips Petroleum Company, 1937; J. W. Cowles, Shell Oil Company, 1938; G. G. Oberfell, Phillips Petroleum Company, 1939; Dr. G. G. Brown, University of Michigan, 1940.

Purpose of the award and method of selecting the recipient were set out by the Natural Gasoline Association of America, its sponsor, as follows:

"Donor of the award is E. I. Hanlon, chairman of the board of the National Bank of Tulsa and of the Hanlon Companies, and a pioneer of the natural gasoline industry.

"In addition to the public acknowledgment of meritorious service the award takes tangible form in a suitably engraved solid gold watch and memento chain. The recipient's name also is engraved on a bronze plaque which hangs permanently in the offices of the association.

"Anyone whose individual effort or outstanding service has resulted in constructive developments in any of the following phases of the natural gasoline industry is eligible to receive the award:

"1. Research of any kind tending to create a broader use of natural gasoline or liquefied products;

"2. Manufacturing processes or equipment which permit greater yield or more economical operation.

"3. Test methods and procedure, creation of standards, delineation of specifications or advancement in laboratory technique.

"4. Handling, storage or transportation of natural gasoline.

"5. Marketing, gas contracting, accounting, public or industrial relations, safety developments, or any business phase of the natural gasoline industry.

"Final selection of recipient is made by an award committee from nominations submitted by interested oil companies, institutions and organizations. This committee consists of the president, secretary-treasurer and the chairman of the technical committee of the Natural Gasoline Association of America. They will be assisted by an advisory committee of five members chosen from the board of directors of the association."

cations was made public July 12, 1921. Since then there have been seven revisions: December, 1922; October, 1924; November, 1925; November, 1927; July, 1928; January, 1932; January, 1938.

The research programs through which the association has made some of its greatest contributions to the industry have been concerned with the composition of motor fuels and their performance characteristics in automotive engines. These studies were begun in 1926 and two subjects on the annual convention program of that year pointed the way:

"Characteristics of Natural Gasoline as a Non-Detonating Agency," A. Ludlow Clayton, Sun Oil Company;

"Relation of Volatility to Acceleration and Anti-Knock Qualities of Natural Gasoline," Dr. E. H. Leslie and Dr. G. G. Brown, University of Michigan.

Research Gets Going

By July of that year arrangements had been completed whereby Dr. Brown became director of the research program, which was carried through in cooperation with the University of Michigan. Objective of this project was to determine the minimum volatility of motor fuels which would give satisfactory performance in the cars of 1926 to 1928. Coupled with this aim, however, was an educational campaign broadly emphasizing the valuable characteristics of natural gasoline as a blending agent in motor fuels.

In setting up specifications the association had convinced the refining industry that natural gasoline could be provided to meet existing needs. Through the research program both the refiner and the automobile manufacturer were shown that natural gasoline had desirable qualities, which neither was using. Specifications satisfied a known need; research singled out advantages in natural gasoline as a motor fuel ingredient and offered methods of adapting these advantages in finished gasoline and automobile operation.

By the time this phase of the research program was completed in 1930, natural gasoline was no longer a product that could be used when conditions in refining permitted but rather a product that should be considered as an essential of motor gasoline.

In its second phase the motor fuel-automotive studies turned toward investigation of the vapor lock problem. While Dr. Brown carried on independently at the University of Michigan, a joint project with the Cooperative Research Committee and the Society of Automotive Engineers was started at the United States Bureau of Standards in 1932 under the direction of Dr. O. C. Bridgeman. The actual causes of vapor lock were studied in extensive road tests with cars of many makes and under all road and weather conditions. As a result of this work additional research was initiated in which car fuel systems were modified to improve performance obtainable from the increased volatility of available fuels. Road tests with cars of 1934, 1935 and 1936 models proved the advantage of designing cars to take full advantage of more volatile fuels. By the time the report of the Pawhuska Road Tests was made in 1938, it had been established that acceleration, economy and power characteristics of all engines could be improved with the more volatile fuels but that fuel system temperatures were too high to gain full advantage of such fuels. During this period the automotive industry was brought into the discussions and several of its leading engineers took part in the annual conventions.

Bottled Gas Arrives

It was 1930 when bottled gas came before the association. Two years later tentative specifications were ready for commercial propane and butane. Now liquefied petroleum gas is one of the growing phases of plant operation and sales. It serves for domestic use from individual installations, for industrial use where pure fuels are required and is now being introduced into lines of utility concerns to serve whole towns and cities, either as the only fuel or as part of the gas supply.

The affiliated organization, the Natural Gasoline Supply Men's Association, was formed in 1928. Previously manufacturers of equipment had been associate members. In 1927 a committee of manufacturers had charge of entertainment for the annual meeting. The result was that by the next year the manufacturers decided to form their own association, whose activity is restricted to furnishing entertainment to the Natural Gasoline Association of America.

A complete history of the association would require a complete program of each annual meeting. Since this would run into excessive words, the next best approach is to select from each meeting some subject or some decision, which designates a trend in the industry.

The first meeting, Tulsa, May 27 and 28, 1922, was largely for organization purposes, although preliminary conferences previously had brought the organization into existence. The meeting drew 130.

That the stabilizer was something of promise can be appreciated from the second meeting, Tulsa, April 24, 25 and 26, 1923. J. A. Rafferty, Carbide and Carbon Chemicals Corporation, discussed "The Stabilizer in Gasoline Absorption." George A. Burrell presented "The Charcoal Process." There was a field trip to plants near Tulsa.

Progress had come about in bringing natural gasoline into the refining picture by the third annual meeting, Tulsa, April 23 and 24, 1924, and was set out by W. K. Holmes with "Natural Gasoline—Its Place in a Straight Run Refinery." D. B. Dow, then with the Bureau of Mines, had a paper, "Recovery of Gasoline from Uncondensed Refinery Still Gases," which was read by M. P. Youker.

A subject, later to have more serious and general consideration was the theme for the annual banquet for the fourth meeting, Tulsa, April 22 and 23, 1925, "The Power of the Government and the Sanctity of Property Rights," by James A. Veasey, chief counsel of Carter Oil Company, now retired.

The fifth annual meeting, Tulsa, May 5 and 6, 1926, was significant in the papers by A. Ludlow Clayton, Dr. E. H. Leslie and Dr. G. G. Brown, to which reference previously has been made. It was the start of the research program. "Economic Value of Natural Gasoline to the Refiner," was the subject of Dr. E. R. Lederer.

An observation that came out of the sixth annual meeting, Tulsa, May 24, 25 and 26, 1937, followed the first progress report on the research program. Dr. Brown evidently startled his hearers when he said that as much as 50 percent of natural gasoline could be blended with motor fuel to advantage. On that "he had to sell the natural gasoline manufacturers themselves." "The Portable Plant," was discussed by S. S. Smith.

Operating Problems

Plant operation was spread through the program of the seventh annual meeting, Tulsa, May 22 and 23, 1928, with these sub-

Officials of the Natural Gasoline Association of America

1921

President

W. M. WELCH
Tide Water Associated Oil Company

Vice President

J. C. SMITH
Gilliland Oil Company

Treasurer

H. H. GODDARD
Chestnut & Smith Corporation

1922

President

W. M. WELCH
Tide Water Associated Oil Company

Vice President

D. E. BUCHANAN
Chestnut & Smith Corporation
(Now with Hanlon-Buchanan, Inc.)

1923

President

D. E. BUCHANAN
Chestnut & Smith Corporation
(Now with Hanlon-Buchanan, Inc.)

Vice Presidents

C. C. HERNDON
Skelly Oil Company

FRANK L. CHASE
Lone Star Gasoline Company

1924

President

D. E. BUCHANAN
Chestnut & Smith Corporation
(Now with Hanlon-Buchanan, Inc.)

Vice Presidents

FRANK L. CHASE
Lone Star Gasoline Company

A. M. BALLARD
Sun Oil Company

1925

President

E. L. PECK
Empire Oil & Refining Company

Vice Presidents

F. L. CHASE
Lone Star Gasoline Company

A. M. BALLARD
Sun Oil Company

F. E. RICE
Phillips Petroleum Company

1926

President

E. L. PECK
Empire Oil & Refining Company

Vice Presidents

F. L. CHASE
Lone Star Gasoline Company

A. M. BALLARD
Sun Oil Company

F. E. RICE
Phillips Petroleum Company

1927

President

H. A. TROWER
Phillips Petroleum Company

Vice Presidents

SAM CARNEY
Shell Oil Company
(Now with Phillips Petroleum Company)

E. R. LEDERER
Texas Pacific Coal & Oil Company
(Now a consulting engineer, Philadelphia)

GEORGE RATCLIFFE
General Petroleum Corporation
(Now with Baroid Sales Division, National Lead Company)

1928

President

H. A. TROWER
Phillips Petroleum Company

Vice Presidents

SAM CARNEY
Shell Oil Company
(Now with Phillips Petroleum Company)

E. R. LEDERER
Texas Pacific Coal & Oil Company
(Now a consulting engineer, Philadelphia)

GEORGE RATCLIFFE
General Petroleum Corporation
(Now with Baroid Sales Division, National Lead Company)

1929

President

E. R. LEDERER
Texas Pacific Coal & Oil Company
(Now a consulting engineer, Philadelphia)

Vice Presidents

A. J. SCHLOSSER
Barnsdall Oil Company

EMBY KAYE
Skelly Oil Company
(Now with Distillate Engineering & Processes Company)

GEORGE RATCLIFFE
General Petroleum Corporation
(Now with Baroid Sales Division, National Lead Company)

1930

President

E. R. LEDERER
Texas Pacific Coal & Oil Company
(Now a consulting engineer, Philadelphia)

Vice Presidents

A. J. SCHLOSSER
Barnsdall Oil Company

EMBY KAYE
Skelly Oil Company
(Now with Distillate Engineering & Processes Company)

R. E. BECKLEY
Standard Oil Company of California

1931

President

S. S. SMITH
Shell Oil Company

Vice Presidents

G. M. CAMPBELL
United Gas Public Service Company

EMBY KAYE
Skelly Oil Company
(Now with Distillate Engineering & Processes Company)

W. W. ROBINSON, JR.
The Texas Company

1932

President

S. S. SMITH
Shell Oil Company

Vice Presidents

G. M. CAMPBELL
United Gas Public Service Company

O. C. FIELD
O. C. Field Gasoline Corporation

EMBY KAYE
Skelly Oil Company
(Now with Distillate Engineering & Processes Company)

1933

President

D. C. WILLIAMS
Continental Oil Company

Vice Presidents

EMBY KAYE
Skelly Oil Company
(Now with Distillate Engineering & Processes Company)

W. E. REARDON
Coltexo Corporation

R. C. WHEELER
General Petroleum Corporation

1934

President

D. C. WILLIAMS
Continental Oil Company

Vice Presidents

JOHN B. ATKINS
Parade Gasoline Company

W. E. REARDON
Coltexo Corporation

R. C. WHEELER
General Petroleum Corporation

1935

President

T. R. GOEBEL
Skelly Oil Company
(Now with Shell Oil Company)

Vice Presidents

R. E. HAYLETT
Union Oil Company

FRED F. KETCHUM
Owens, Libbey-Owens Gas Department

W. E. REARDON
Coltexo Corporation

1936

President

T. R. GOEBEL
Skelly Oil Company
(Now with Shell Oil Company)

Vice Presidents

R. E. HAYLETT
Union Oil Company

FRED F. KETCHUM
Owens, Libbey-Owens Gas Department

W. E. REARDON
Coltexo Corporation

1937

President

J. A. LA FORTUNE
Warren Petroleum Corporation

Vice Presidents

R. E. BECKLEY
Standard Oil Company of California

J. R. JARVIS
Lone Star Gasoline Company

RAY E. MILLER
Hanlon-Buchanan, Inc.

1938

President

J. A. LA FORTUNE
Warren Petroleum Corporation

Vice Presidents

R. E. BECKLEY
Standard Oil Company of California

J. R. JARVIS
Lone Star Gasoline Company

RAY E. MILLER
Hanlon-Buchanan, Inc.

1939

President

GEORGE P. BUNN
Phillips Petroleum Company

Vice Presidents

J. R. JARVIS
Lone Star Gasoline Company

RAY E. MILLER
Hanlon-Buchanan, Inc.

J. W. VAIDEN
Skelly Oil Company

1940

President

GEORGE P. BUNN
Phillips Petroleum Company

Vice Presidents

J. R. JARVIS
Lone Star Gasoline Company

RAY E. MILLER
Hanlon-Buchanan, Inc.

J. W. VAIDEN
Skelly Oil Company

★

Secretary-Treasurer

1921-1928

A. V. BOURQUE

1928-1934

RAY E. MILLER

1934-----

WILLIAM F. LOWE

jects: "Theory and Practice of Automatic Controls," T. G. Laney; "Theory and Practice of Fractionation in Natural Gasoline Plants," L. S. Gregory; "Gas Lift and Repressuring and Their Relation to the Natural Gasoline Industry," H. B. Bernard. The progress report on research had to do with vapor lock and G. G. Oberfell discussed "Volatility of Natural Gasoline."

The storage problem brought two papers to the program for the eighth annual meeting, Tulsa, May 21, 22 and 23, 1929: "Gasoline Storage as Practiced in the Natural Gasoline Industry," by G. M. Davidson, and "Is Present Gasoline Storage Adequate to Best Serve the Industry?" by H. C. Charles.

That natural gasoline as a motor fuel ingredient was growing in favor was evident from subjects on the program of the ninth annual meeting, Tulsa, May 20, 21 and 22, 1930. The subjects were: "Natural Gasoline from a Refiner's Viewpoint," M. H. Nolan; "Choice of Natural for Blending," S. S. Smith; "Blending Value of Natural Gasoline," E. W. Zublin. This program was the first to bring natural gasoline out as a source of aviation motor fuel in a paper by R. C. Alden and Billy Parker.

Economic trends of all industry had their effect on the program of the tenth annual meeting. What proration of oil field production was doing to natural gasoline manufacture had much consideration at Tulsa, May 19, 20 and 21, 1931. A bit of gloom hovered about, for natural gasoline was a cent and a half a gallon.

For the eleventh annual meeting, Tulsa, May 17, 18 and 19, 1932, the program still gives evidence that economic conditions were troublesome. "Broad Discussion of Economics of the Natural Gasoline Industry," was the title for something of a round-table discussion, which followed the reading of the paper by R. C. Alden. By that time the East Texas field had established itself as a prolonged source of natural gasoline and G. H. L. Kent, Humble Oil & Refining Company, brought the development of plant construction and prospects before the meeting. Technical subjects included "Properties of Hydrocarbons at High Pressures as Applied to the Design of Absorbers, Strippers and Stabilizers," G. G. Brown, University of Michigan.

Evidence of the growing importance of liquefied petroleum gases came from the move to write tentative specifications for commercial propane and butane. Also G. G. Oberfell, Phillips Petroleum Company, had a paper, "Specifications, Stenches and Markets for Liquefied Petroleum Gases."

With vapor lock studies under way from a decision of the previous year, the twelfth annual meeting, Tulsa, May 15, 16 and 17, 1933, the subject was brought up to date in a paper, "The Present Status of the Vapor Lock Problem," Dr. O. C. Bridgeman, H. S. White and F. B. Gray, Bureau of Standards, Washington. Investigation of vapor locking of motor fuels by road tests had been undertaken in cooperation with the Cooperative Fuel Research Steering Committee.

H. M. Trimble, Phillips Petroleum Company, presented "Comparison of Anti-Knock Characteristics of Vapor Recovery and Natural Gasoline Blends." "The Performance of Motor Fuels," was the subject of Dr. G. G. Brown.

As a prelude to the theme of the thirteenth annual meeting, Tulsa, May 9, 10 and 11, 1934, it should be noted that several months previous THE REFINER AND NATURAL GASOLINE MANUFACTURER had printed several columns under the heading, "Code of Fair Competition for the Petroleum Industry." So NRA was an industrial flag of the period.

A long resolution to the Planning and Coordination Committee, seeking changes in the petroleum code was a part of the deliberations of the thirteenth annual meeting. Harold L. Ickes, whose name later was to become familiar to the petroleum industry, asked that a committee from the association come to Washington.

Volatility Theme

Volatility of motor fuels was the theme of the fourteenth annual meeting, Tulsa, May 1, 2 and 3, 1935. That volatility of motor fuel reached beyond natural gasoline and had the attention of refining and automobile design was evident from the program. A. D. Bauer and A. E. Becker, Standard Oil Development Company, presented the subject from the viewpoint of refining. "Automobile Design as Related to Fuel Volatility," was the title selected by T. A. Boyd, John M. Campbell and Wheeler G. Lovell, General Motors Research Corporation. J. B. McCauley and Gilbert Way, Chrysler Corporation, had a part on the symposium, which required one day of the meeting. The discussion was closed by Dr. G. G. Brown, who gave the viewpoint of the natural gasoline manufacturer. A report on the petroleum code was made by William F. Lowe, secretary.

For the fifteenth annual meeting, Tulsa, May 13, 14 and 15, 1936, Dr. G. G. Brown summed up the results of his work with the association under the title, "Ten Years of Research."

This meeting again brought the automotive industry into contact with volatile motor fuel and its relation to automobile design and vapor lock. "Fuel Volatility as Viewed by the Automotive Engineer," was the subject of Gilbert Way, Chrysler Corporation, while Wheeler G. Lovell, General Motors Research Corporation had the subject, "Automotive Design Changes and Their Relation to Modern Motor Fuels."

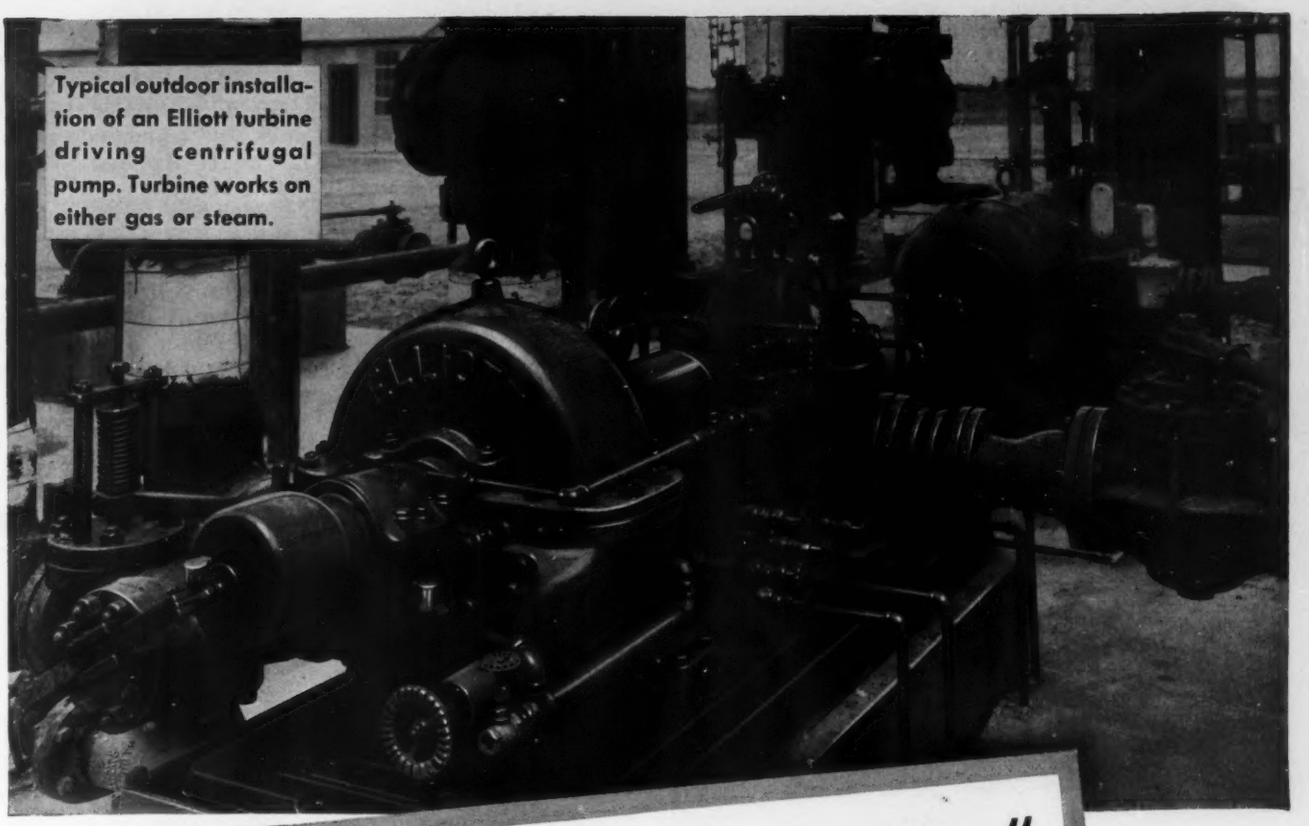
Improvement in the economic status of the natural gasoline industry was evident throughout the sixteenth annual meeting, Tulsa, May 19, 20 and 21, 1937. T. R. Goebel, who completed his service as president that year, pointed out that increase in output was not keeping pace with increase in total consumption of motor fuel. Factors in this were blending with crude oil in transportation, blending with Gulf Coast naphthas for gasoline production, blending with refinery output over a wider seasonal range and increase in exports.

Outside Influences

The influence of advancements in other parts of the industry were part of the annual program. E. O. Bennett, Continental Oil Company, had a paper, "Combined Crude Stabilization, Natural Gasoline and Pressure Maintenance," which described production methods of the Tepetate field. A paper by Dr. G. G. Brown and Donald L. Katz, University of Michigan, "Polymerization and What It May Mean to the Natural Gasoline Industry," brought a refining advancement to the program.

The seventeenth annual meeting, Tulsa, May 11, 12 and 13, 1938, brought the report on the Pawhuska Road Tests, which was read by T. W. Legatski, Phillips Petroleum Company.

As in the previous year the influence of other parts of the industry, especially refining, on natural gasoline dominated the program. "Influence of Refining Trends on Natural Gasoline," was the subject of



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TURBINES FOR DEPENDABLE DRIVES

John W. Newton, Magnolia Petroleum Company. Arch L. Foster, then technical editor of National Petroleum News, had the subject "Trends in Refining Processes as They May Affect Natural Gasoline."

A development, which has gained the wrong designation—recycling—came into deliberations of the association for the eighteenth annual meeting, Tulsa, May 3, 4 and 5, 1939. On the program was "Retrograde Condensation and the Critical Phenomenon," Dr. G. G. Brown, University of Michigan. What it all meant was that nature had provided higher pressures than those practical in natural gasoline manufacture, consequently scientists and manufacturers had accomplished absorption at these higher pressures.

Liquefied petroleum gas, a subject frequently considered for several past meetings, was of sufficient importance to have a dominant place on the program of the nineteenth annual meeting, Tulsa, May 15, 16 and 17, 1940. James W. Vaiden, Skelly Oil Company, handled the subject under the title, "Economics of Liquefied Petroleum Gas as It Applies to Natural Gasoline Manufacture." Retrograde condensation again came to the program with "Developments in Gas Recycling Plants," E. E. DeBack, Corpus Christi Corporation. "Neohexane, Thermal Alkylation," was presented by R. C. Alden, Phillips Petroleum Company.

History of the Natural Gasoline Supply Men's Association

In words the history of the Natural Gasoline Supply Mens' Association is brief. This situation exists not because the organization is without activity but because it was started with a single objective and it has clung to that policy. These activities are restricted to serving in harmony with the Natural Gasoline Association of America and to promoting a closer relationship between supply men and members of NGAA.

Each year it provides the entertainment for the annual meeting of NGAA. That was the purpose of the organization and to that it was restricted in the constitution. Recently it has sponsored the compilation of the Technical Bulletin, or handbook, containing a wealth of essential engineering data for the design and operation of gasoline plants, testing of products, gas measurement and control. In this it has expanded beyond the limits of the natural gasoline industry, for popularity of the bulletin has made its distribution decidedly welcome to other phases of the petroleum industry and engineering schools have thought so well of it that it has become a text book in several instances.

The restriction in activity has given the Natural Gasoline Supply Mens' Association a singular record. It is one association which never has held a convention. It is never concerned about dates for a meeting, place for a meeting or a program. Time and place of meeting are determined by decisions of the Natural Gasoline Association of America, which means that 1941 will mark the first time any of its activity has been outside of Tulsa. It is unique to find an association which does not have an annual banquet to its credit.

It has been host for numerous banquets, smokers, luncheons and dances, with its own members and those of the Natural Gasoline Association of America as the guests. Such is its primary purpose.

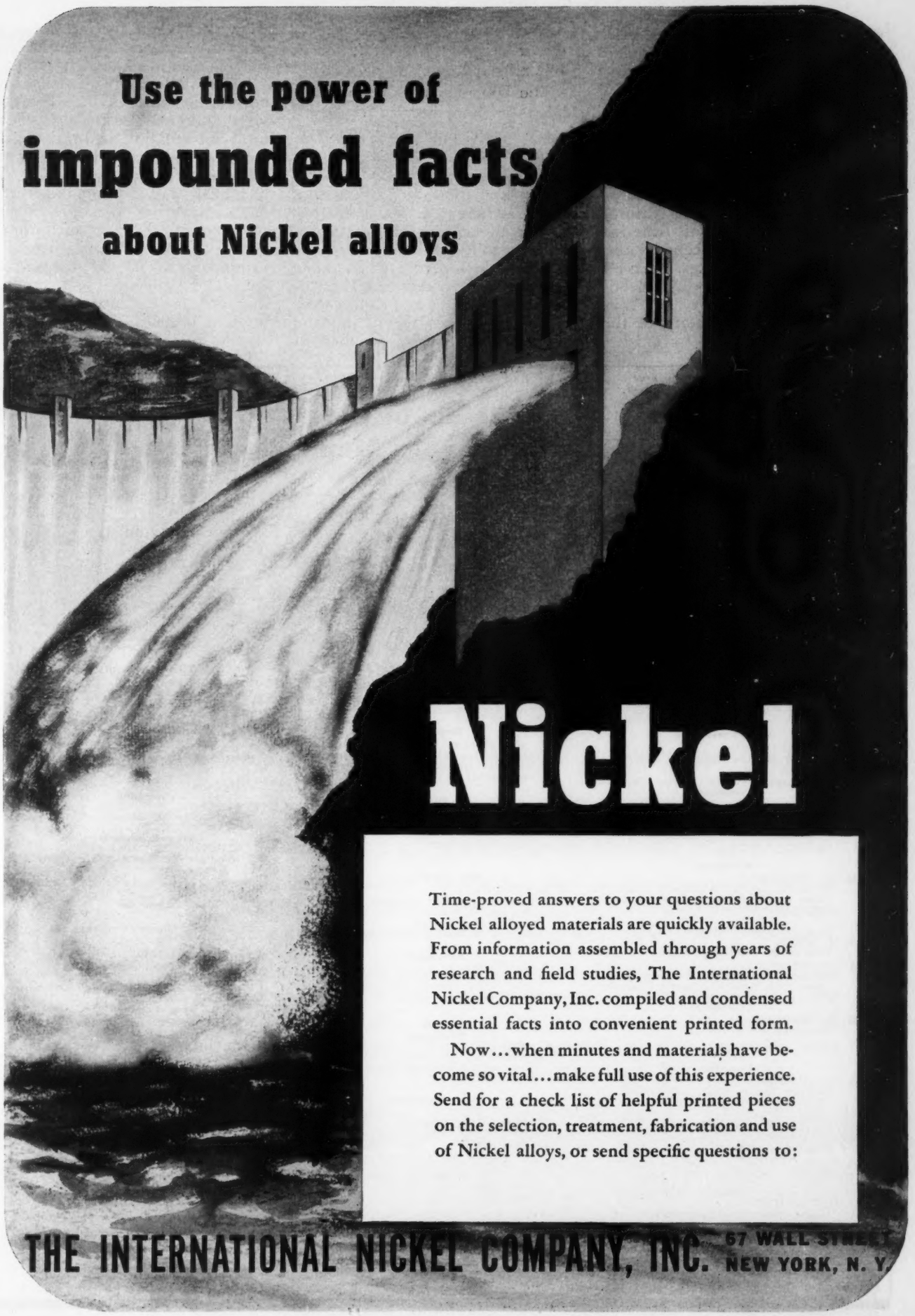
Prior to 1928 manufacturers and distributors of equipment were associate members of NGAA. a provision of its by-laws. For the annual meeting in 1927 several association members through a committee took charge of entertainment. This resulted in manufacturers making plans for a better organized, joint entertainment for the next meeting, to take the place of the more expensive and distracting entertainment of delegates by individual supply companies. Well ahead of this meeting, a temporary committee of organization was selected by I. H. Satterwhite, Westcott & Greis, as chairman. Several committee meetings resulted in the decision to form what should be termed an associated organization.

The Natural Gasoline Supply Mens' Association accordingly was formed May 22, 1928, opening day of the seventh annual meeting of NGAA. It assumed full responsibility for all entertainment of the meeting and restricted its future activity to this function in its constitution. Since then it has been repeating the organized entertainment year after year with whatever success the imagination of committee members, the ability of the entertainment world and the wizardry of chefs and decorators can offer. The arrangement has been highly satisfactory for both associations and closer ties between the two are the natural result.

Membership in the association is by companies, which in turn designate individuals to serve for the brief business session when officials and directors are elected each year. These individuals also make up the several committees which bring the entertainment features into harmony with the program of each annual meeting of the Natural Gasoline Association of America.

Well in advance of each annual meeting these committees are named. They confer frequently with officials and committee members of the other association to the end that the proper number of luncheons, the annual dinner and dance or the smoker serve their entertainment purpose with the least confusion to the general program. These committees continue to function until the annual meeting has closed.

The annual meeting of the Natural Gasoline Supply Mens' Association itself is a brief affair. It takes place in some room of the hotel where the NGAA convention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is in session. Reports of officials, especially those of the secretary and the treasurer, are heard. Officials and directors for the next year are elected. With that a motion to adjourn is in order.

During the year dues are paid. While dues involve membership in the Natural Gasoline Supply Mens' Association, they also involve associate memberships in the Natural Gasoline Association of America and a portion of each fee goes into the treasury of the latter, since all bookkeeping and other office detail is done in the NGAA office. William H. Lowe is secretary of the two organizations.

Development of the Technical Bulletin recently was described in a letter from Lowe as follows:

"The book started originally in 1935 as a minor service to the industry and perhaps a larger advertising effort for member companies. In 1936 there was more technical information but advertising still predominated. In the 1937 bulletin advertising was restricted to one small card space for each member, which permitted inclusion of 80 pages of good technical information. Two thousand copies were printed and there was a demand for nearly twice that number. It went to several foreign countries and a number of engineering schools used it as text material.

"The bulletin, which has not been issued since 1937, is being revised and enlarged for 1941. Technical information is furnished by engineering departments of natural gasoline manufacturing concerns, technical staffs of manufacturing and engineering companies and by trade papers. Because of its popularity in 1937, 3000 copies are being printed this year. Distribution is free. The association asks gasoline manufacturing concerns to designate individuals to whom copies should be sent.

Officials of the Natural Gasoline Supply Men's Association

1928-1929

President

J. H. SATTERWHITE
Westcott & Greis, Inc.

Vice Presidents

M. F. WATERS
Hanlon-Waters, Inc.

W. A. SCHLUETER
Refinery Supply Company

Treasurer

D. W. McKAY
Hope Engineering & Supply Company
(Now with Cooper-Bessemer Corporation)

1930

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Hanlon-Waters, Inc.

Vice Presidents

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Refinery Supply Company

A. J. KERR
Pittsburgh Equitable Meter Company

Treasurer

M. H. KOTZEBUE
Tulsa Boiler & Machinery Company
(Now with Gasoline Plant Construction Corporation)

1931

President

M. H. KOTZEBUE
Tulsa Boiler & Machinery Company
(Now with Gasoline Plant Construction Corporation)

Vice Presidents

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Pittsburgh Equitable Meter Company

A. W. BURKETT
Jackson Engineering Corporation
(Now with Griscom-Russell Company)

Treasurer

M. F. WATERS
Hanlon-Waters, Inc.

1932

President

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Jackson Engineering Corporation
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Moorlane Company

A. V. B. CANDLER
National Supply Company

Treasurer

E. H. TRIPHAUS
Taylor Instrument Company

1933

President

W. D. MOORER
Moorlane Company

Vice Presidents

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B. W. Vinson Company, Inc.

A. V. B. CANDLER
National Supply Company

Treasurer

M. H. KOTZEBUE
Tulsa Boiler and Machinery Company
(Now with Gasoline Plant Construction Corporation)

1934

President

B. W. VINSON
B. W. Vinson & Company, Inc.

Vice President

J. H. SATTERWHITE
Westcott & Greis, Inc.

Treasurer

M. H. KOTZEBUE
Tulsa Boiler & Machinery Company
(Now with Gasoline Plant Construction Corporation)

1935

(To June 1)

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Petroleum Engineering, Inc.

Vice Presidents

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Taylor Instrument Company

G. B. LANE
The Foxboro Company
(Now with Vinson Supply Company)

Treasurer

J. A. LUPFER
Worthington Machinery Corporation
(Now with Hercules-Lupfer Engine Sales Company)

1936

President

J. A. LUPFER
Worthington Machinery Corporation
(Now with Hercules-Lupfer Engine Sales Company)

Vice Presidents

G. B. LANE
The Foxboro Company
(Now with Vinson Supply Company)

D. W. McKAY
Cooper-Bessemer Corporation

Treasurer

W. D. MOORER
Moorlane Company

1937

President

G. B. LANE
The Foxboro Company
(Now with Vinson Supply Company)

Vice Presidents

D. W. McKAY
Cooper-Bessemer Corporation

D. E. FIELDS
Tulsa Boiler & Machinery Company

Treasurer

W. D. MOORER
Moorlane Company

1938

President

D. W. McKAY
Cooper-Bessemer Corporation

Vice Presidents

D. E. FIELDS
Tulsa Boiler & Machinery Company

A. J. KERR
Pittsburgh Equitable Meter Company

Treasurer

V. C. CANTER
Frick-Reid Supply Corporation

1939

President

D. E. FIELDS
Tulsa Boiler & Machinery Company

Vice Presidents

A. J. KERR
Pittsburgh Equitable Meter Company

W. W. WOOBANK
Woobank Pump & Machinery Company

Treasurer

E. H. TRIPHAUS
Taylor Instrument Company

1940

President

A. J. KERR
Pittsburgh Equitable Meter Company

Vice Presidents

W. W. WOOBANK
Woobank Pump & Machinery Company

L. S. ALLEN
National Tank Company

Treasurer

GEORGE W. PROBST
Clark Brothers Company

1941

President

W. W. WOOBANK
Woobank Pump & Machinery Company

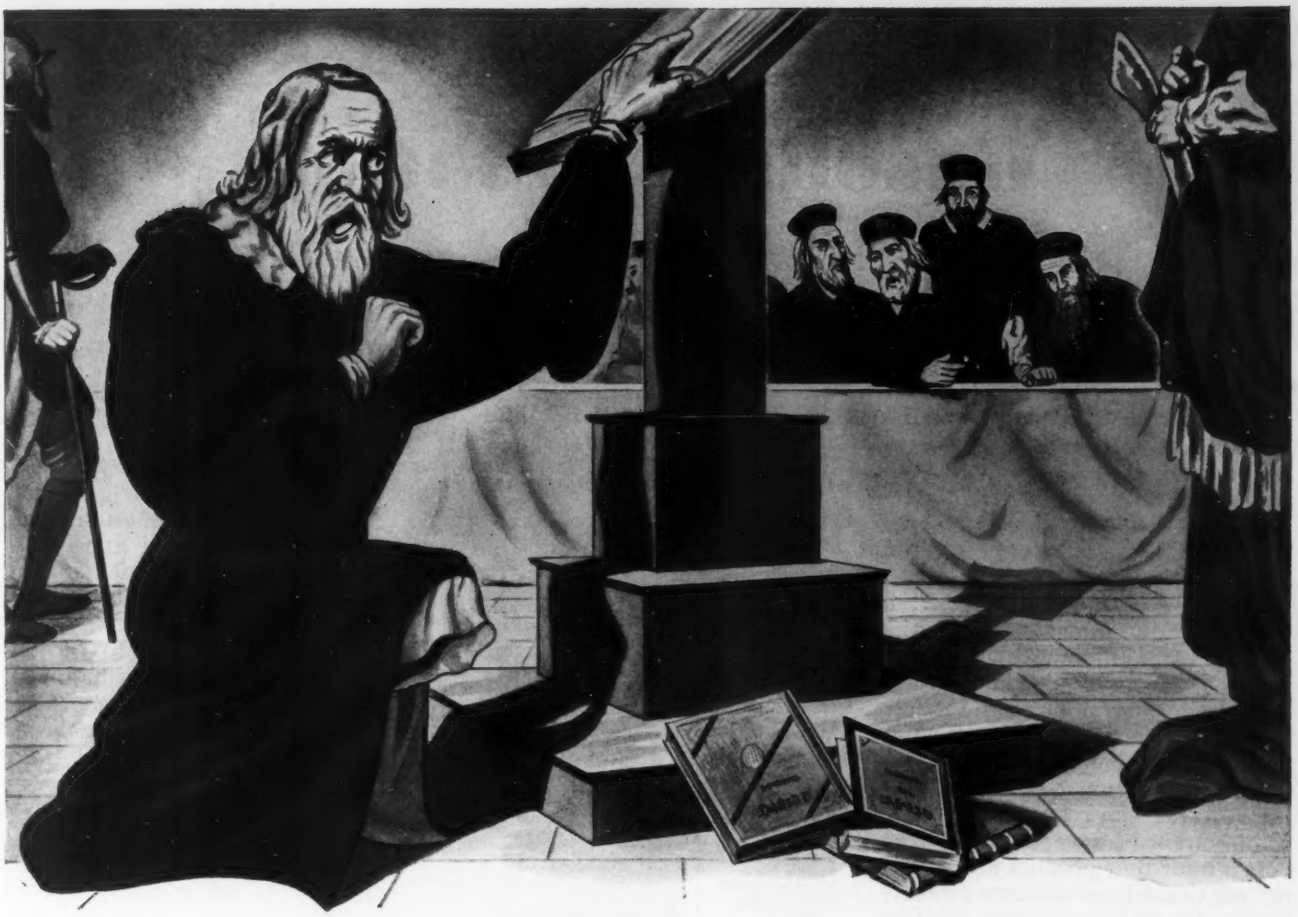
Vice Presidents

L. S. ALLEN
National Tank Company

GEORGE W. PROBST
Clark Brothers Company

Treasurer

D. A. LEACH
Chicago Bridge & Iron Company



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Outlook Improved by Better Gasoline Situation

L. J. LOGAN

THE petroleum industry's statistical situation has continued to show gradual improvement, and unless current trends are interrupted, operations should become increasingly satisfactory as the year progresses.

Probably most significant of the changes now under way is the gradual strengthening of the market for gasoline, although other noteworthy developments include firming of lubricants and stiffening of the crude-oil markets.

The improvement of the market for gasoline has resulted from the combination of unexpectedly large demand for that product and a better relationship of current production and stocks to the demand. The fall-winter accumulation of stocks has been held within fairly moderate proportions, with current production held down through relatively low cuts of gasoline from crude at the refineries and through the absence of any necessity for excessive runs to stills in providing adequate current production of heating oils. (Last winter, severe weather forced serious overproduction of gasoline along with fulfillment of demand for burning oil.) Stocks of gasoline consequently are several millions of barrels smaller now than at this time last year, whereas demand is materially larger.

Gasoline Market Improving

Wholesale and retail prices of gasoline so far have improved only a little over the extremely low levels to which they sank in 1940. But recent weeks have brought definite strengthening of the markets, from the refining districts of the Southwest and Middle West to the harbors of the Atlantic Coast and to interior marketing areas. And continued betterment of the gasoline market is confidently expected by refiners. (Currently, the average tank car price of regular grade gasoline is approximately ¾ cent a gallon lower than at this time last year, and the average tank wagon price is almost a whole cent lower.)

Stocks of finished and unfinished gasoline in the United States (including aviation gasoline) totaled 98,979,000 barrels on March 15, a quantity 2,310,000 barrels, or 2.3 percent, less than the 101,289,000 barrels on hand at the middle of March last year.

When the inventories of aviation gasoline are broken out of those totals, the statistical position with regard to gasoline appears even more favorable. For present stocks (March 15) include 6,547,000 barrels of aviation gasoline, while those of a year ago included only 4,261,000 barrels—an increase of large percentage but one that is welcomed.

Current (March 15) stocks of regular gasoline, therefore, amount

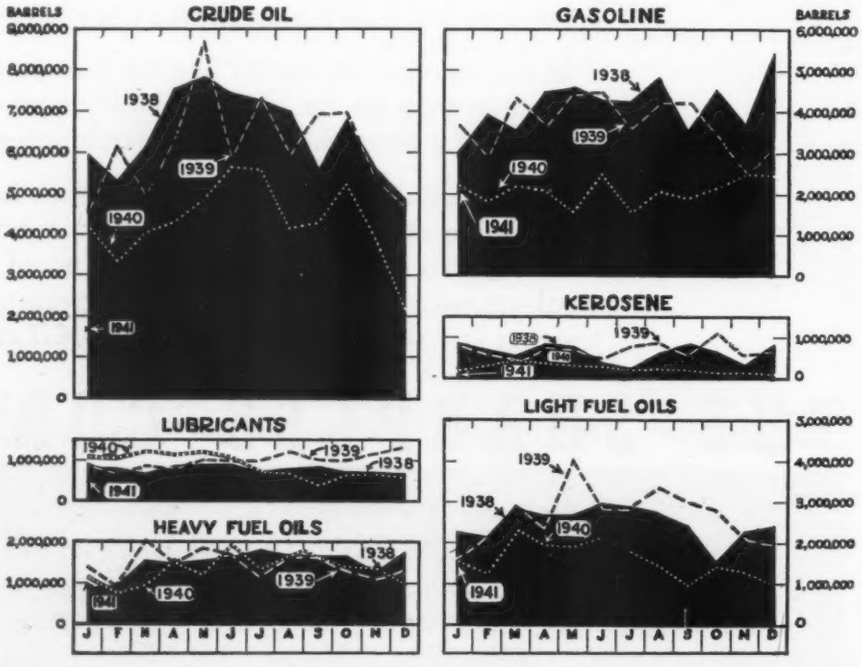
Exports of Both Crude and Refined Oils Smaller Than Year Ago

Figures indicate barrels and are from Bureau of Mines.

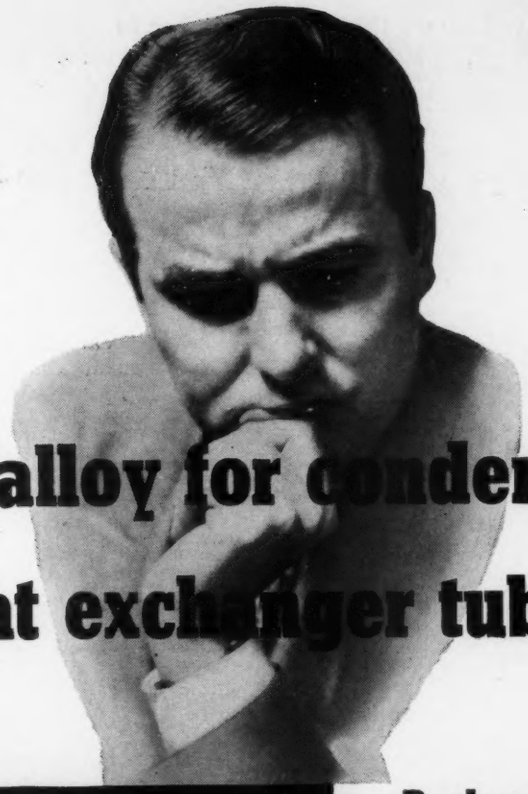
ITEM	JANUARY 1940	JANUARY 1941	Percent Change
Crude Oil	4,202,000	1,687,000	— 59.9
Products:			
[2]Motor Fuel	2,274,000	2,045,000	— 10.1
Aviation Gasoline (included above)	178,000	[1]440,000	+147.2
Kerosene	391,000	92,000	— 76.5
Gas Oil & Distillate	1,549,000	1,595,000	+ 3.0
Residual Fuel Oil	1,139,000	1,002,000	— 12.0
Lubricants	1,068,000	534,000	— 50.0
Wax (thousands of pounds)	21,142	13,229	— 37.4
Coke (short tons)	16,600	11,300	— 31.9
Asphalt (short tons)	19,300	21,900	+ 13.5
Miscellaneous Oils	40,000	29,000	— 33.9
[3]Total Refined Products	6,726,000	5,531,000	— 17.8
Total Crude and Products	10,928,000	7,218,000	— 33.9

[1] Includes 298 barrels anti-knock compounds.
[2] Includes benzol—1,000 barrels in January, 1941.
[3] Not the sum of the above figures, some of which do not indicate barrels.

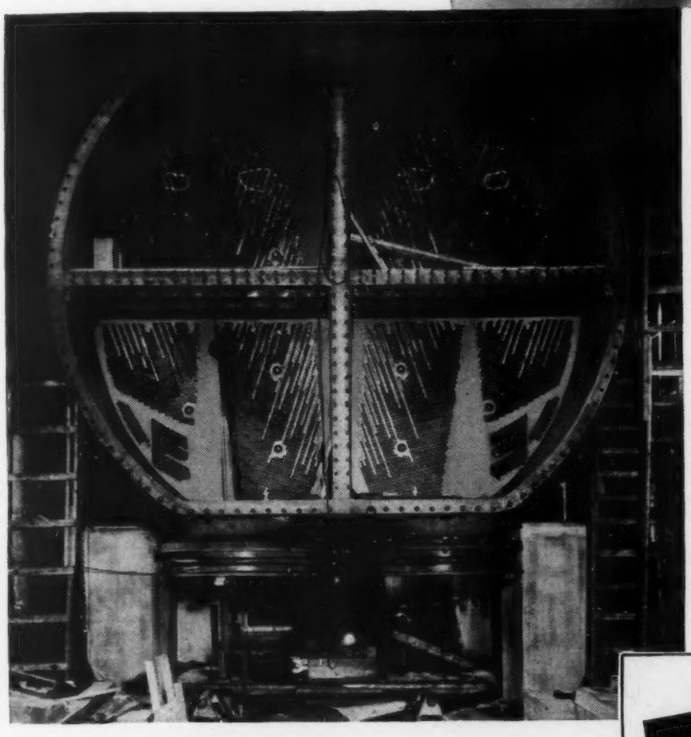
U. S. Exports of Crude Petroleum and Refined Products



Source of Data: Bureau of Mines.



What alloy for condenser and heat exchanger tubes ?



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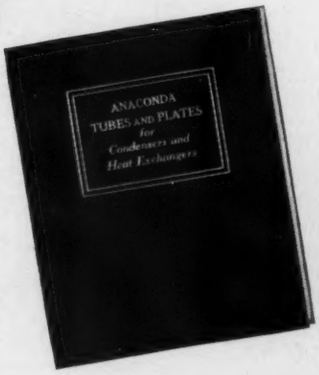

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to 92,432,000 barrels, as compared with 97,028,000 barrels on hand a year ago; the present supply being 4,596,000 barrels, or almost 5 percent, smaller than that held at this time last year.

Meanwhile, total demand for gasoline appears to be running around 10 percent higher than in 1940, in the face of somewhat smaller exports, as domestic consumption has been exceptionally large.

Figures recently published by the Bureau of Mines showed that total demand for motor fuel was 11.1 percent larger in January, 1941, than in January, 1940. Exports were down 10.1 percent, from 2,274,000 to 2,045,000 barrels, but domestic consumption was up 12.3 percent, from 40,370,000 to 45,344,000 barrels.

Similar gains in total and domestic demand for gasoline have been indicated for February and March.

These increases have been larger than expected, and apparently have reflected pronounced stimulation of domestic consumption by the national defense program as well as relatively mild weather, which has permitted greater than usual winter use of automobiles.

Light Fuel Oils

While this winter's comparatively mild weather has promoted large consumption of gasoline, it conversely has held down requirements of light fuel oils for heating purposes. Demand for those oils, consequently, has been smaller than expected, with the result that markets have weakened, although not seriously, in the past month.

Total demand for gas oil and distillate fuel, consisting largely of heating oil, was 5.9 percent smaller in January, 1941, than in January, 1940, when severe weather caused extraordinary consumption, the market requirements having totaled 22,593,000 barrels, against 24,011,000. Exports were slightly larger, but domestic demand was down 6.5 percent, from 22,462,000 to 20,998,000 barrels.

Kerosene was used in the United States in slightly larger volume in January, 1941, than in January, 1940, but exports were off almost to the vanishing point, with the result that total demand was down approximately 1 percent, from 7,924,000 to 7,861,000 barrels.

There was some weakening of the prices of light fuel oils around March 1, with mild weather persisting and the close of the heavy consuming season approaching. But subsequent cold weather revived demand, accelerated withdrawals from storage and strengthened the markets.

Viewed from all angles, the situation with regard to light fuel oils has been and continues satisfactory. The comparatively large stocks of those oils on hand during the past year and now in storage have been good insurance against severe weather. And the presently held inventories likely will be advantageous in making provision for the large demand of next fall and winter. Consumption of heating oil continues to grow every year, as new burners are installed in homes and other buildings; and any surplus that might accumulate temporarily should be worked off without difficulty. The ever-present danger in connection with heating oil is that of allowing stocks to shrink too much. For when the inventory becomes small in relation to demand, production must be maintained on an emergency basis, entailing the processing of more crude than necessary for supplying adequate quantities of gasoline and other products, as evidenced by the industry's unsatisfactory experience in the fall and winter of 1939-1940.

Heavy Fuel Oils

Developments so far have confirmed earlier expectations of comparatively large demand for heavy fuel oils. Although total requirements were greater in 1940 than in

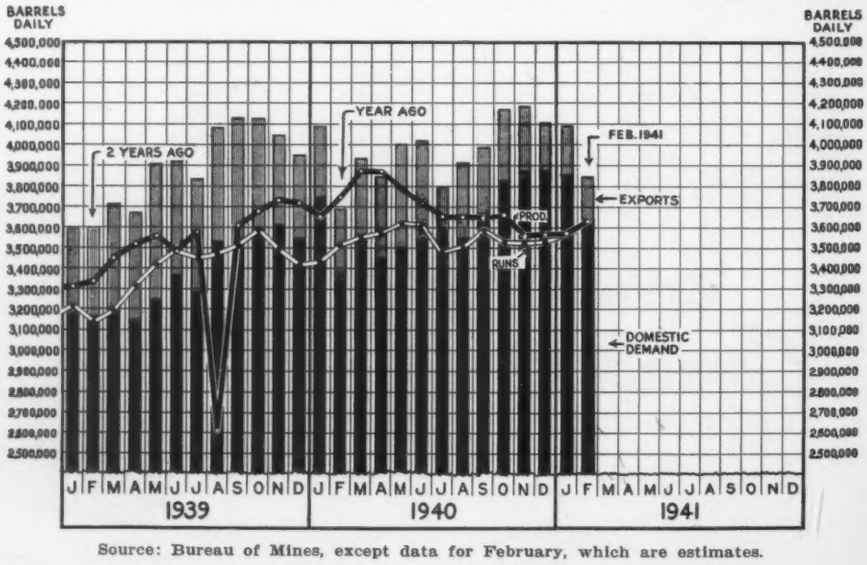
January Oil Demand Higher in 1941 Than in 1940

Figures indicate barrels, and are from Bureau of Mines.

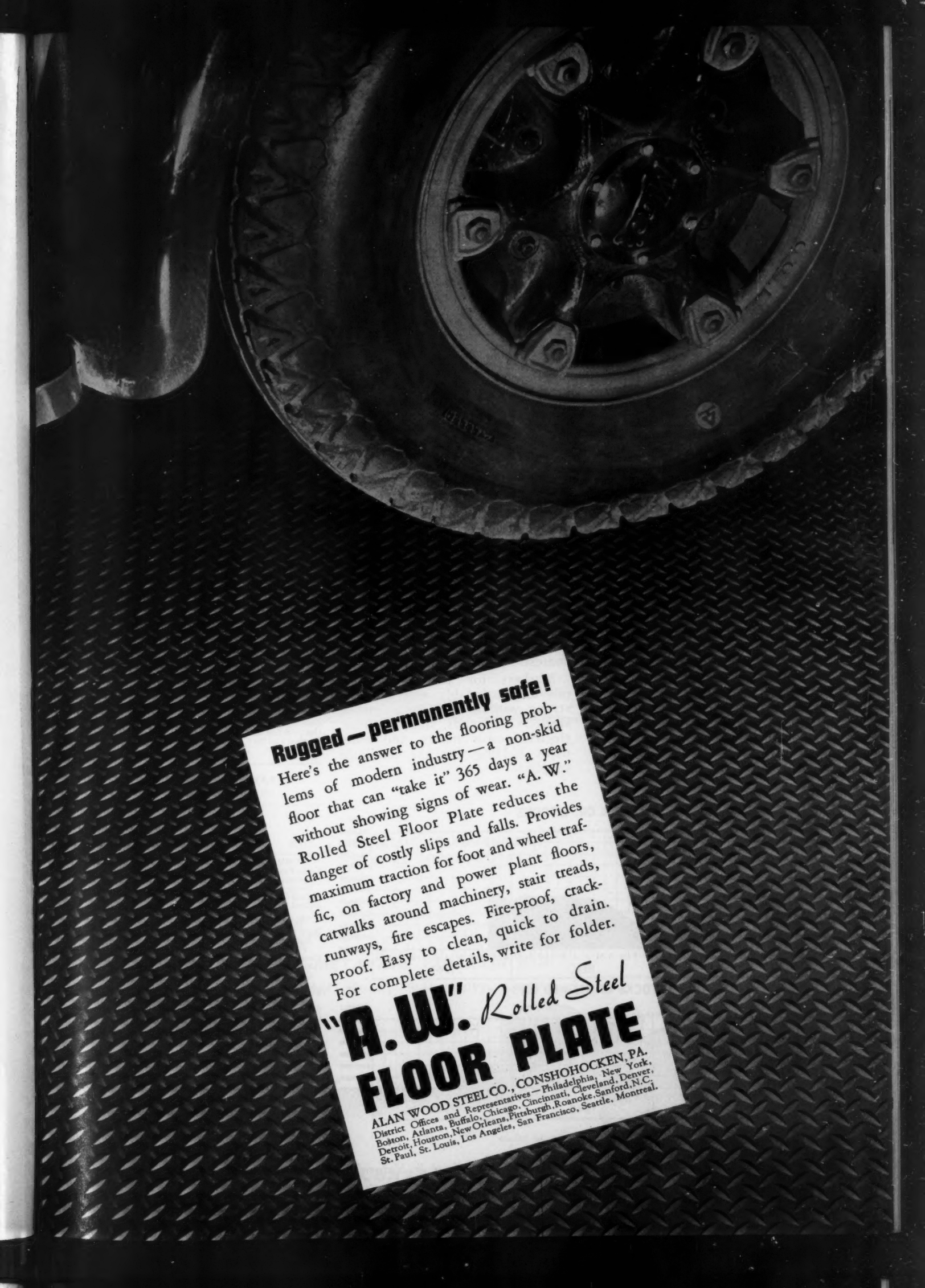
ITEM	JANUARY 1940	JANUARY 1941	Percent Change
SUMMARY—			
Total Demand	126,719,000	126,752,000	+ 0.02
Daily Average	4,088,000	4,089,000	— 0.02
Exports:			
Crude Petroleum	4,202,000	1,687,000	—59.9
Refined Products	6,726,000	5,531,000	—17.8
Total Exports	10,928,000	7,218,000	—33.9
Domestic Demand:			
Total Domestic Demand	115,791,000	119,534,000	+ 3.2
Daily Average	3,735,000	3,856,000	+ 3.2
TOTAL DEMAND FOR PRODUCTS			
Motor Fuel:			
Domestic	40,370,000	45,344,000	+ 12.3
[1]Exports	2,274,000	2,045,000	— 10.1
Total	42,644,000	47,389,000	+ 11.1
Aviation Gasoline: (included above)			
Domestic	[3]504,000	563,000	+ 11.7
Exports	178,000	[3]440,000	+147.2
Total	682,000	1,003,000	+ 47.1
Kerosene:			
Domestic	7,642,000	7,769,000	+ 1.7
Exports	391,000	92,000	— 76.5
Total	7,924,000	7,861,000	— 0.8
Gas Oil and Distillate Fuels:			
Domestic	22,462,000	20,998,000	— 6.5
Exports	1,549,000	1,595,000	+ 3.0
Total	24,011,000	22,593,000	— 5.9
Residual Fuel:			
Domestic	32,473,000	33,338,000	+ 2.7
Exports	1,139,000	1,002,000	— 12.0
Total	33,612,000	34,340,000	+ 2.2
Lubricants:			
Domestic	2,054,000	2,367,000	+ 15.2
Exports	1,068,000	534,000	— 50.0
Total	3,122,000	2,901,000	— 7.1
Wax (thousands of pounds)			
Domestic	35,187	37,724	+ 7.2
Exports	21,142	13,229	— 37.4
Total	56,329	50,953	— 9.5
Coke (short tons):			
Domestic	137,800	195,500	+ 41.9
Exports	16,600	11,300	— 31.9
Total	154,400	206,800	+ 33.9
Asphalt (short tons):			
Domestic	149,500	206,500	+ 38.1
Exports	19,300	21,900	+ 13.5
Total	168,800	228,400	+ 35.3
Road Oil:			
Domestic	132,000	125,000	— 5.3
Miscellaneous:			
Domestic	240,000	242,000	+ 0.8
Exports	40,000	39,000	— 2.5
Total	280,000	281,000	+ 0.4

[1] Includes benzol—1,000 barrels in January, 1941.
[2] Includes 298,000 barrels anti-knock compounds.
[3] Revised and comparable.

DEMAND FOR ALL U.S. OILS • CRUDE OIL PRODUCTION • REFINERY RUNS


BARRELS DAILY
2 YEARS AGO
YEAR AGO
FEB. 1941
EXPORTS
PROD.
RUNS
DOMESTIC DEMAND
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941

Source: Bureau of Mines, except data for February, which are estimates.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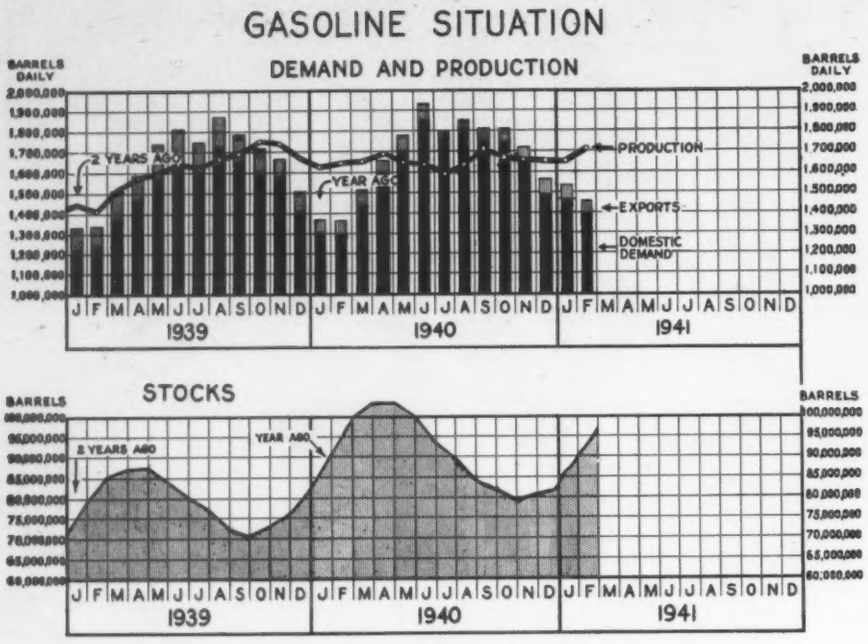
GASOLINE SITUATION
DEMAND AND PRODUCTION
BARRELS DAILY
2 YEARS AGO
YEAR AGO
PRODUCTION
EXPORTS
DOMESTIC DEMAND
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
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STOCKS
BARRELS
2 YEARS AGO
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1939
1940
1941

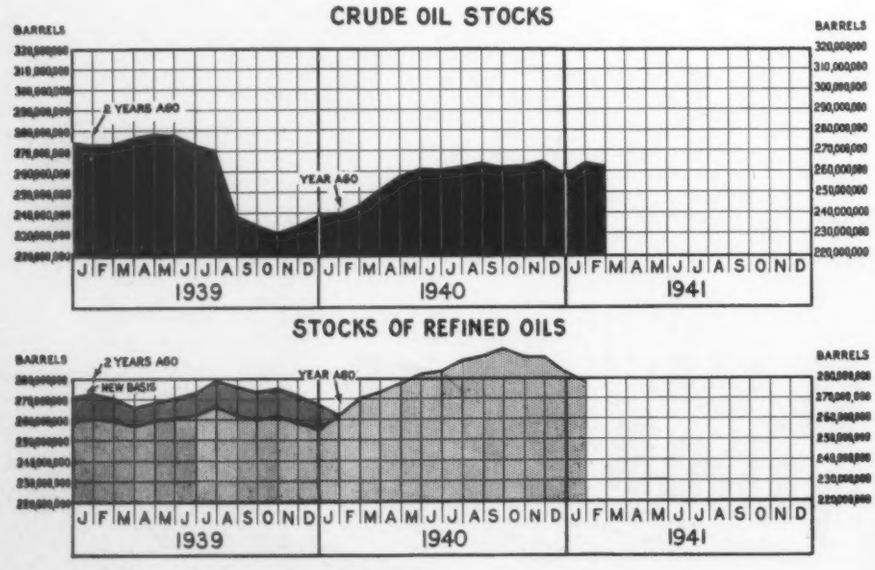
Source: Bureau of Mines, except data for February, which are estimates.

any previous year, in the face of a small decrease in exports, the total demand is showing further moderate expansion this year, in response to the brisk industrial activity induced by the defense program.

In January, 1941, the markets absorbed 34,340,000 barrels of the residual fuel oils, or 2.2 percent more than the 33,612,000 barrels reported for January, 1940, according to the Bureau of Mines. Exports were down 12 percent, from 1,139,000 to 1,002,000 barrels, but domestic consumption was up 2.7 percent, from 32,473,000 to 33,338,000 barrels.

Continued large demand in February and March has been evidenced by steady withdrawals from storage, which averaged over 600,000 barrels weekly between February 1 and March 15. The stocks came down in that period from 100,428,000 to 96,661,000 barrels, despite comparatively large imports as well as high levels of domestic production.

Markets for the heavy fuel oils unquestionably will continue strong, with factories, mills, mines, smelters, railroads, shipping lines, electric power plants, and other users bidding for the available supplies.


CRUDE OIL STOCKS
BARRELS
2 YEARS AGO
YEAR AGO
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
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STOCKS OF REFINED OILS
BARRELS
2 YEARS AGO
NEW BASIS
YEAR AGO
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1939
1940
1941

Source of Data: Bureau of Mines

Exports normally constitute a relatively large proportion of the demand for lubricants, and the war has greatly curtailed foreign sales. But the loss of export business now is being partially compensated by pronounced expansion of domestic demand, with the industrial component of United States requirements enlarged through the defense activities.

Domestic demand for lubricants amounted to 2,367,000 barrels in January, 1941, compared with 2,054,000 barrels in January, 1940, an increase of 15.2 percent. But inasmuch as exports were down 50 percent, from 1,068,000 to 534,000 barrels, there was shown for total demand a 7.1 percent decrease, from 3,122,000 to 2,901,000 barrels.

Later this year, figures on demand for lubricants, as for other products, may be expected to show up more favorably, because comparisons so far in 1941 have been against exceptionally large demand in early 1940.

Changes from Year Ago in Stocks of Crude and Refined Oils in the United States

(Figures indicate Barrels)

LATEST WEEKLY DATA

(Sources: Crude stock, Bureau of Mines; all other figures American Petroleum Institute.)

STOCKS OF:	Mar. 16, 1940	Mar. 15, 1941	Percent Change
Gasoline	101,289,000	98,979,000	— 2.3
Gas Oil & Distillate	23,938,000	31,643,000	+ 32.1
Residual Fuel Oil	103,031,000	96,661,000	— 6.2
Crude Oil	[1]245,762,000	[2]264,001,000	+ 7.4

LATEST MONTHLY DATA

(Source: Bureau of Mines)

ITEM	Stocks at End of January		Percent Change
	1940	1941	
SUMMARY—			
Crude Petroleum:			
Refinable in U. S.	239,794,000	263,251,000	+ 9.8
Heavy in California	13,385,000	11,839,000	— 11.6
Natural Gasoline	4,476,000	5,490,000	+ 22.7
Refined Products	262,791,000	278,551,000	+ 6.0
Total all Oils	520,446,000	559,131,000	+ 7.4
Days' Supply:			
January Basis	127	137	+ 7.9
PRODUCTS—			
Gasoline:			
Finished	84,863,000	83,310,000	— 1.8
Unfinished	4,476,000	5,490,000	+ 22.7
Total	89,339,000	88,800,000	— 0.6
Aviation Gasoline (included above)	[3]3,918,000	6,595,000	+ 68.3
Kerosene	4,918,000	8,312,000	+ 69.0
Gas Oil & Distillate	26,462,000	37,938,000	+ 43.4
Residual Fuel Oils	89,281,000	86,258,000	— 3.4
Lubricants	7,328,000	8,809,000	+ 20.2
Wax (thousands of pounds)	74,575	120,027	+ 60.9
Coke (short tons)	628,000	406,000	— 35.4
Asphalt (short tons)	593,000	689,000	+ 16.2
Road Oil	763,000	717,000	— 6.0
Miscellaneous	288,000	360,000	+ 25.0
Other Unfinished Oils	36,108,000	39,542,000	+ 9.5

[1] Stocks March 9, 1940.
[2] Stocks March 8, 1941.
[3] Revised and comparable.

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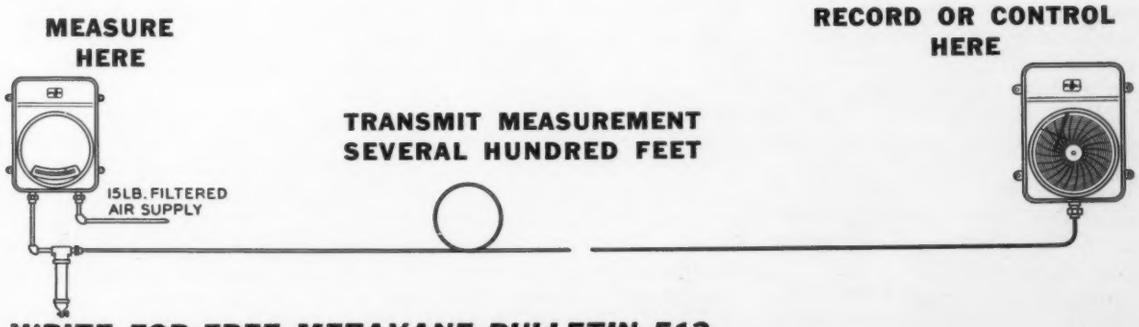

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Practical Economics of Cycling

B. B. BOATRIGHT and P. C. DIXON
Foran, Boatright & Dixon

THE accompanying article presents in practical form a discussion of factors which, in the ultimate analysis, determine the probable degree of success and profit to be derived from a cycling enterprise. In order to coordinate the presentation of many divergent subjects it has been written as though directed to persons who seek a pattern about which they may intelligently attack the problem of inspecting and possibly developing a cycling project. It was presented at the Spring Meeting of the Southwestern District of the American Petroleum Institute at Shreveport, Louisiana, February 27, 1941.

A GREAT deal has been written concerning the fundamental laws governing the phenomena of retrograde condensation, the design and operation of cycling plants, and other technical phases of cycling projects, but relatively little attention has been paid the more broad and fundamental business aspects that must be considered by the average operator.

Cycling operations in condensate bearing gas fields are assuming an important role in the oil industry. Thirty-one plants, with a combined processing capacity of some 1¼ billion cubic feet of gas per day, are now recovering about 25,000 barrels of condensate daily. Approximately three times as much gas was processed by cycling plants in 1940 as in 1939; contemplated plants for 1941 may bring the total amount of gas being processed to twice the 1940 figure. Obviously, there are definite reasons for this rapid increase.

The art of cycling has progressed well beyond the experimental stage and its development has provided a means of recovering condensate reserves that would otherwise be irretrievably lost and of conserving dry gas for future use. Cycling represents a decided advance in production technique; the combined effects of pressure maintenance and gas drive in a properly designed cycling project result in high recovery efficiency without physical waste.

Cycling projects are more subject to self-enforced economic proration than to governmental proration. Distillate wells can, in many cases, be called little more than "dry holes," presuming the usual lack of gas market. A wildcat well, finding distillate but no oil shows, can not be called dry and yet the distillate can not be produced by conventional separator methods because of wasteful gas-liquid ratios. In order to protect the well investment and to hold the lease, it is common for the operator to set pipe and thus bring to being another of those enigmas, a distillate well. Were such a discovery an oil well, twenty acre offsets would be justified and have almost certain possibilities of success; being a distillate well, this offset distance must be materially increased, with attendant uncertainty of securing any kind of production. In selecting the offset distance, the operator may presume that there will be a "ring of oil," that elusive and usually unprofitable strip sometimes found between the water and the gas, or he may presume that the entire structure is gas, in which latter case an offset well on 180-acre spacing might have no value if the final method of production is by cycling. If the distillate content and the well pressure are average, the total condensate reserve in the reservoir in which this hypothetical well is completed will be about fifty barrels per acre foot. The economic returns that may be expected from prospecting for reserves as marginal as these are certainly not great and yet certain interests are now petitioning for the application of state proration to these projects; certainly physical waste can not be shown. A comparison of the economic returns per dollar invested, production per acre per day, or investment per barrel of distillate in place in the reservoir for comparable oil and condensate pools will show that arbitrary proration is not justified if it would curtail production from the average present day plant.

In spite of the fact that about 150 gas-distillate fields are known, the development of cycling projects will not be unduly rapid. Relatively few projects are economically feasible and, even under ideal conditions, from one to two years usually elapse before a given project can be completed. The reasons for this lapse of time become apparent when the various steps which must be taken are analyzed.

Preliminary Investigation

A preliminary investigation is always advisable before seriously considering any cycling project, as very often this casual survey will reveal conditions that preclude a reasonable chance of success. This survey need not be exhaustive but should include a brief investigation of available data to determine (a) that the distillate content of the gas is sufficient to justify treatment; (b) that there is a possibility of unitizing sufficient acreage to assure an adequate gas reserve; (c) that contractual requirements are not prohibitive or, in the event they are prohibitive, that they can be modified; (d) that well potentials are sufficiently high so that an excessive number of wells will not be needed; and (e) that subsurface conditions are favorable for cycling.

Detailed Investigation

In the event that a cycling project appears desirable after preliminary examination, a thorough evaluation is in order. It is obviously impossible to recite all the variations incidental to each step of the analysis, but an attempt will be made to present the general procedure involved and to identify the

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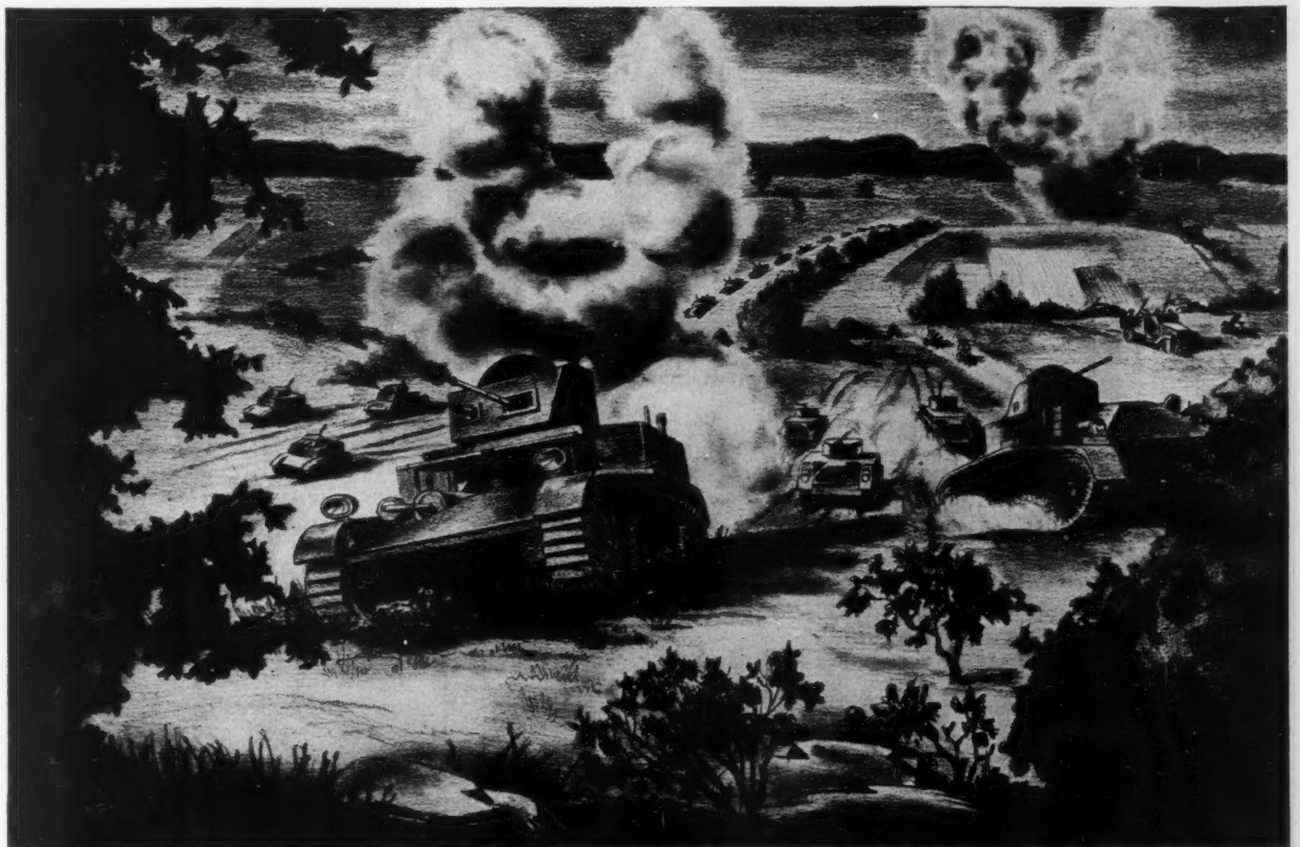

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Sampling of the well products must be conducted with a maximum degree of accuracy, for all economic considerations will be based upon the computed recovery shown from this test. The probable degree of accuracy may bear a relationship to the time of test, or to the degree of refinement of gas and liquid measurement, but in any event the limits of accuracy are known by the person conducting such a test and these limits should be carried through to the final balance sheet of proposed operations.

Reserves—Total reserves in place in the reservoir must be calculated, and this is done in the conventional manner. Deviation due to supercompressibility and surface shrinkage due to condensation of liquids should be determined and the proper correction factors applied if these factors are in excess of the limits of accuracy of the metering or the analyses from which the factors must be calculated. Average sand thickness is derived from the customary sources, but at this point a new element may enter some calculations. If the reserve calculations were being made to determine total gas reserves in place and available for pipe line sale, the entire sand section containing gas is usually weighed for average porosity and connate water to determine the void space containing gas. If this method of reserve calculation is used, then the factor of cycling efficiency later applied in order to obtain recoverable reserves should be correspondingly lowered, depending upon the degree of shaling or lensing indicated by well records and depending also upon the amounts of shale present in the cores to reduce the average vertical permeability and thus prevent free gas movement in a vertical direction. On the other hand the well logs may be studied carefully to determine the average sand thickness through which effective circulation appears possible. This latter thickness will be less than that formerly described and might be called effective sand thickness. In applying this effective sand thickness to the estimate of total recoverable reserves, the factor of cycling efficiency may be relatively high. In any event, however, the results obtained by the two methods should give comparable figures of total recoverable reserves.

If structure and sands are defined with reasonable geologic exactness,

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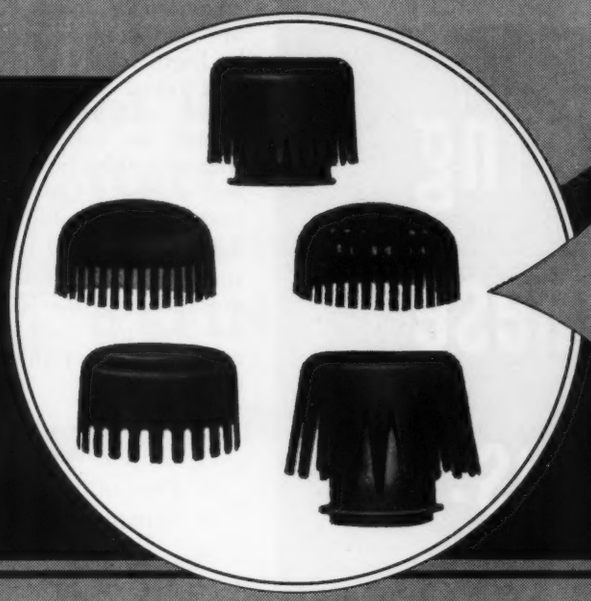

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a calculation of total gas-distillate reserves is more exact, on a barrel basis, than similar calculations of dark oil reserves; further, although differences of opinion exist as to the efficiency of gas circulation or displacement within the possible limits of 40 percent to 70 percent efficiency, the calculation of ultimate recovery is at least as exact, on a barrel basis, as similar calculations of dark oil recovery and economically considerably more exact because the factor of lifting cost is omitted and the factor of discount is minimized.

Development and Drainage Pattern—From the strictly theoretical standpoint, it is possible to completely develop a hypothetical unitized field of about 4000 acres and to cycle and recover its distillate reserve in a hypothetical 90 million foot plant with a maximum of approximately ten wells. Such fields will probably never exist in reality because in the first place this number or more wells will probably be drilled to define the productive structure. This latter situation being the usual case, the operator considering a cycling project is confronted with the problem of designing a drainage pattern to make the best use of presently drilled wells. Drilling obligations must ordinarily be suspended by agreement in the unitization contract and the final development generally produces a drainage pattern that represents a compromise between that which is economically practical and that which is theoretically efficient.

Wells used for cycling service may cost more than ordinary wells due to casing and coring costs. Casing should be about 7 inches in size if workovers to other sands are expected or if flow rates will be high. Every potentially productive sand should be completely cored and every core recovered should be subjected to tests for the determination of connate water, porosity, and horizontal and vertical permeability.

Plant Type and Size—Selection of the type of plant best suited for maximum profit from cycling operations may be dependent upon one or more of the following several factors:

1. Anticipated life of operations.
2. Content of the gas.
3. Type of final products desired.
4. Flowing well head pressure.

The anticipated life of operations should make a material difference in the quality and overall permanent nature of plant construction, assuming, of course, that in no event there can be any sacrifice in the safety features or the safety factors employed.

It has been found that a condensation type plant, either with or without mechanical refrigeration, is not ordinarily best suited to the needs of all particular situations; likewise, it has been found that the oil absorption plant does not in all cases meet the requirements of returning a maximum profit with reasonable flexibility of operations over the life of the project. Distillates have been found to vary widely in their general physical makeup. In some cases the distillate gas is composed primarily of relatively light hydrocarbons, a large proportion of which might ordinarily be constituents of natural gasoline. In other cases the distillate gases have been found to contain extremely heavy hydrocarbons. A fairly definite relationship exists between the content of the gas, for any given reservoir temperature and pressure, and the

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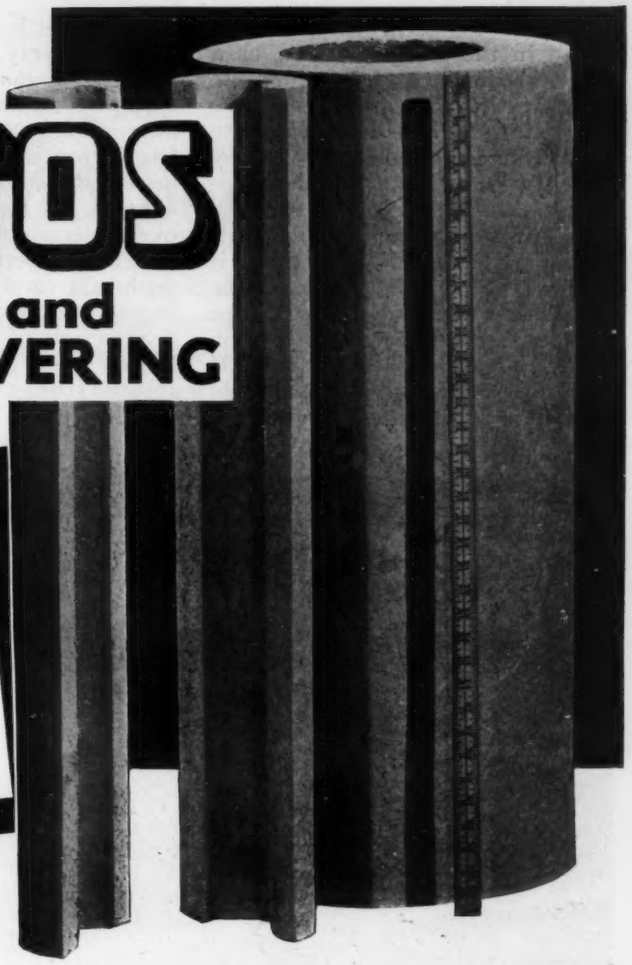

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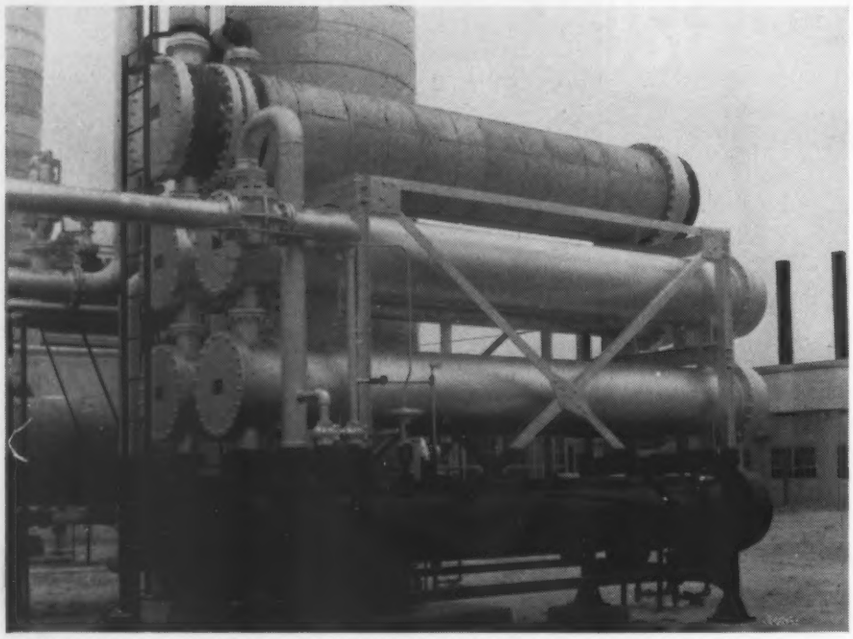
weight of the hydrocarbons contained in the gas phase and, as a rule, the heavier the condensate material, the leaner the gas. These heavy liquids are susceptible to efficient and economic recovery by ordinary condensation and regenerative cooling, providing the well head flowing pressure is sufficiently high. In some fields, then, it may not be possible to justify the installation of a more ornate type of plant, such as an oil absorption plant, if the cooling available through the choke is capable of producing recoveries that yield the greatest net income. On the other hand, recovery from a light distillate gas, if made in a condensate type plant, must be with the assistance of expensive mechanical refrigeration in order to avoid high losses in the form of plant tail-gas content. It has been found that overall economic conditions upon which the operator must figure his profit are rarely, if ever, the same in any two fields.

Selection of plant size is based largely upon the relative economic returns from a range of sizes varying between a large plant with its correspondingly short life and a small plant with an expectation of operating life that approaches the useful economic life of the equipment installed therein. From a practical standpoint, the anticipated life of operations should not be less than five years, and with a greater life than five years the size selected should be one that makes proper and full use of all installed facilities. Costs increase in some types of plant in multiples of from 30 to 60 million foot capacities. In one type of plant, for example, it costs relatively little more to construct a 120 million cubic foot plant than it does a 100 million foot plant because the equipment items which represents a major portion of the investment, including the standby or spare units, are not fully utilized by the 100 million foot capacity. A more common size plant will probably be one of approximately 60 million cubic feet and, in this range, the 60 million foot plant may cost very little more than a 50 million foot plant. Use of the proper size multiples should be considered in connection with the analysis of the cycling project. In a completely unitized field, the optimum size plant will return the greatest profit; in a competitive field, plant size is largely dependent upon equitable exhaustion of reserves.

Unitization—The idea of establishing cycling operations may originate with one or more, or with the entire group, of the operators in the field or with an outside interest. Depending upon the source of the idea, the course of events leading to agreements between the plant operator and each lease operator will undoubtedly be different in each project. One of the greatest problems to be solved, if the operators themselves undertake the venture from the original stages, is that of establishing some group of representative individuals with power to act for their respective companies. The ramifications of developments of the original idea are rather astounding and unless the committee, or person, or company that acts for the entire group of operators is delegated full authority to make lease unitization commitments, it has been found that the process of reaching an agreement amongst the operators may become a hopeless venture. Some operators will have completed more wells than others and with propriety may feel that they are entitled to receive a return par-

"COYNCO"



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When shipments keep so close to plant production that storage is but a little above suction on the pumps, down time becomes a major issue in operation — REFINER AND NATURAL GASOLINE MANUFACTURER, February, 1941 issue

That story is about a Dubbscracking refinery in California and about the notable performance of its superintendent

Here is what he did

From April 16, 1940, to February 6, 1941, he kept that Dubbs unit on stream 97.05 per cent of the time and he is holding the pace

Down time is mighty short

By carefully training his crews and planning every move, he has the unit cleaned out and back on stream in 19 hours from the time the fires are cut The rest of the time it is making Dubbscracked gasoline

It's a good thing he's speedy because the customers go for this gasoline so strong that the plant is pushed to the limit all the time It's generally so in Dubbs refineries everywhere

Congratulations to that superintendent—and to the company he works for

Universal Oil Products Co
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tially dependent upon the size of their present investment as compared with the size of other operators' investments. In a large measure, the wells which have been so completed have helped to prove the structure and establish the necessity for the cycling project, but, on the other hand, it is possible that many of these completed wells cannot be profitably employed in cycling operations. One problem that may arise due to this situation will be to compensate some operators for wells already drilled. The amount of compensation requested by these operators with presently developed properties may not be acceptable to other operators with completely undeveloped acreage, and as a result it is not uncommon for the situation to lead to unitization of reserves, with consequent unit operations of a plant, but with each individual operator obligated to develop his own leases on some predetermined drilling density program. In some cases where pure distillate production is obtained it is fallacious to establish arbitrary drilling blocks and to drill, for example, a geometric pattern of wells, one in each 160 or 320 acre block. Some of the wells drilled on such a geometric pattern will not add to the efficiency of reservoir recovery and their cost cannot be reasonably justified.

Another matter in which the operators will be materially interested will be the method of allocation of plant production to the various leases. In fields in which development is advanced, it may be easy to agree upon the reservoir reserves underlying each of the leases controlled by the various operators. In such an event, allocation is most readily made upon the basis of reserves in place. If, due largely to sparse development, material differences exist in independent calculations of total reserves underlying the various leases, then the most feasible method of allocation will doubtlessly be on a straight acreage basis. There are many reasons to justify the allocation of production on a straight acreage basis and such allocation is sensibly made and is advantageous in many respects. It is reasonable to expect that some operators may not be allocated what appears to them to be their full interest in the recoverable production, while to them, others may appear to receive more than their full interest. The difference between the full interest that might theoretically seem to be due and that which is offered may appear to be large and consequently well worth trying to establish. On the other hand, if cycling operations are not undertaken, the difference between the actual interest proposed in the cycling project and the actual recovery anticipated to be made from the reservoir by other production means will cause to appear insignificant any relatively small differences that might seem to exist under the unitization plan.

In some cases it is not possible to unitize the entire field at one time, but it may be possible to organize a sufficient number of units or a single unit of sufficient size to justify commencing operations. In this event, it is customary to add other units or additional acreage from time to time providing, however, that such provision has been made in the original unitization agreement with the first unit group. If a fair and equitable distribution of the recoverable condensate is made, the originally recalcitrant operators are very apt

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we are again happy to extend
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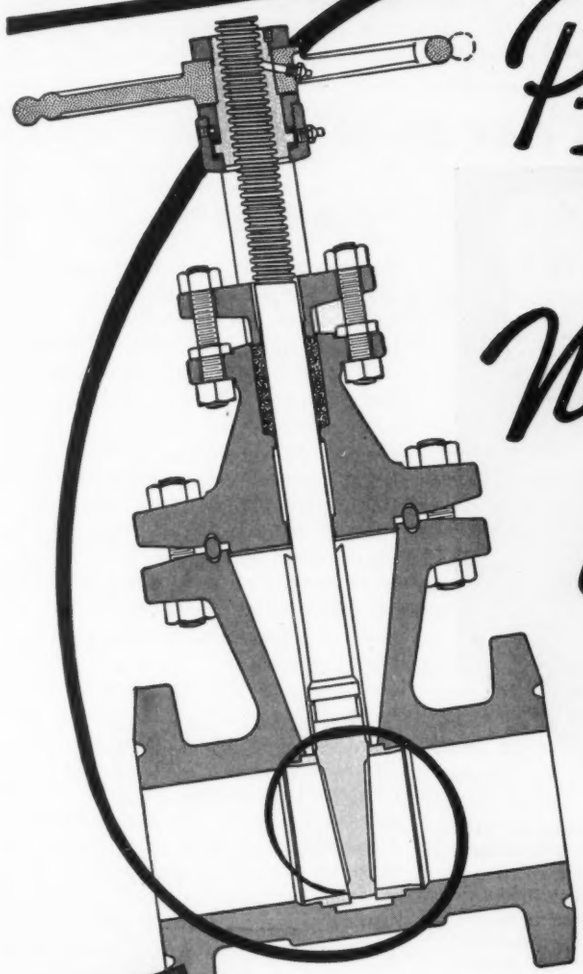

- NO THREADS to corrode or leak—Metal-to-metal contact of rolled-in seat rings provides a tight seal and reduces maintenance to a minimum.
- DOUBLE TIGHTNESS obtained by contact between body and seat on both the shoulder and the flare end of the seat.
- SEATS WON'T TURN or loosen in service, due to special design.
- STREAMLINE FLOW thru the valve—Absence of lugs or wrench grips minimizes turbulence and reduces pressure drop.
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DROP FORGED STEEL VALVES

to modify their opinions and desire admission to the unit operations in preference to either constructing a plant of their own, or of seeing their reserves swept away, or of using their acreage in any type of competitive operation.

During and after assembly of the original cycling unit, it behooves all of the field operators to very carefully consider any acts or agreements which do not make provision for an equitable outlet for every lease and which thereby invite competition. Properly conducted, competitive operations may neither add to nor detract from the ultimate recovery of lease reserves or their economic value; but unfortunately strategic acreage may make reserve recovery proportional only to plant capacity. Certain relief from this situation is obvious by application of our knowledge of dry gas movement in the formation. When viewed from the economic perspective, the obvious and most sensible solution to probable competitive operation is cooperative, amicable, and sensibly planned joint activities. Leases which are strategically located outside the operating units are potential competitors regardless of size or the probable economics of a cycling installation thereon. Some cycling projects have been commenced without sufficient economic life in their proved reserves to return their investment costs.

Royalty interests are ordinarily thought to be difficult of unitization but such may not be the case. If the content of the distillate gas is sufficiently high to permit paying the full 1/8th of the plant products, or other royalty required in the mineral and subsequent leases or transfers, it is usually a relatively easy matter to obtain majority interest signatures on the necessary unit agreement and division order. If the distillate content of the gas is relatively low, a cycling project may not be feasible unless the royalty payments can be reduced. The probable success of a request for royalty payment reduction is partly dependent upon the past production history of the particular property. If the field is relatively new, royalty owners may be inclined to believe that, in spite of the contention of the lease holder for reduced payments on account of lean content, the property, being productive, is very valuable and the royalty is likewise valuable. These distillate gases cannot be produced by ordinary means and after completion of the original well, or wells, royalty owners are surprised and disappointed at the lack of income from these supposedly valuable properties. As a result, certain psychological factors are at play in dealings with the royalty owners, relatively little difficulty being encountered in securing agreement to a reasonable unitization plan if the property has been wholly or partially developed without attendent material production, while considerable difficulty is often times encountered if little or no development has taken place. The royalty unitization agreement should contain many provisions, including the following:

1. The right to co-mingle gas for processing and the right to inject dry gas anywhere on the structure.

2. The method of allocating production between units, if more than one unit is organized.

3. The method of apportioning production within the unit.

4. A provision for reducing, or

It's Bound to Come

Yes, we predict "It's bound to come"—that other inverted bucket traps must eventually be offered with straight-through piping because steam trap buyers are demanding it. This design is so important, so simple, so logical, so economical for the customer, so well received by the field that we predict other traps will sometime in the future bring out similar designs.

Super-Silvertop steam traps! There's the optional elbow connection with no extra fittings—there's the guided inverted bucket that gives true engineering control to bucket motion. Also, the lever and valve mechanism that provides greater condensate capacity in a case of no greater size. With Anderson Super-Silvertop you can put a blowdown at the bottom of the trap. Besides, Super-Silvertops can be taken apart and inspected right on the line—no need to disturb pipe connections.

Straight-through piping for inverted bucket traps was first offered in an Anderson trap nine years ago in the Anderson Silvertop No. 11. Six years ago, all traps in the Super-Silvertop line were redesigned to include straight-in-line piping. But that's not all you get with Anderson

Get all the facts about Anderson Super-Silvertop—send for your copy of "How To Choose a Steam Trap," write today for your copy of this helpful book.

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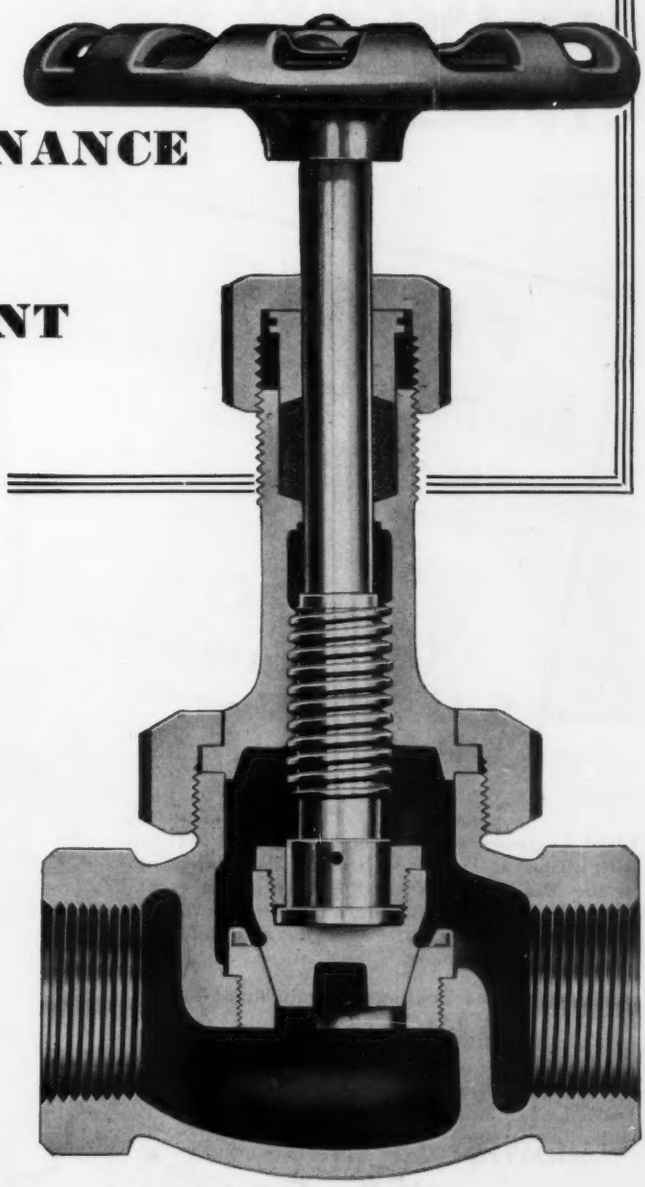
1942 WEST 96th STREET • CLEVELAND, OHIO

Super-Silvertop
STEAM TRAPS

The 500 Brinell seats and discs of this Walworth Bronze Valve

CUT VALVE MAINTENANCE TO THE VANISHING POINT



The surfaces of these seats and discs cannot be marred by boiler scale, sand, grit and the like. These foreign particles are crushed between the seat and disc and pass on without scratching the surfaces. Even after years of severe service this valve assures tight shut-off. It is truly the longest-wearing bronze valve you can buy.

Every part has been carefully designed and constructed to assure you maximum protection against wear and leakage. The stainless steel discs and seats have been heat-treated to a minimum Brinell hardness of 500. Extra large stems and extra long stem-thread contacts have been provided to give the advantage of increased valve life and minimum thread wear.

The valves are identified as Fig. 225P for the Globe Valve and Fig. 227P for the Angle Valve. They are available in sizes from ¼ inch to 2 inches, and are recommended for general service on steam, air, oil, water and gas up to 350 p.s.i. at 550° F.

For complete details on this long-life, economical Walworth Bronze Valve contact your nearest Walworth distributor, or write for Bulletin No. 87. It gives complete information, including sizes, dimensions, specifications and prices.

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entirely eliminating, drilling obligations.

5. A provision which will allow for the entrance of additional acreage to the unit on an equal sharing basis, or a provision which will permit the establishment of additional units, either of which provisions should set forth the minimum quantities of gas that must be processed for recovery.

6. A provision for the sale of residue gas and the method of allocating income derived therefrom.

7. A provision to allow the plant operator a reasonable quantity of gas for plant fuel and processing loss.

8. An arbitration clause which may be invoked in the customary manner.

9. A description of the methods of testing and measuring the distillate content for purposes of allocating or apportioning production.

Arrangements for Financing, Constructing, and Operating Cycling Project—Due to the relative newness of cycling operations some financing agents have been hesitant to participate because of lack of experience. Generally speaking, however, a good and potentially profitable enterprise can be readily financed. There are at least five ways in which to complete project can be handled from its inception to and including its ultimate exhaustion; first the company, or group companies, owning the leases furnishes the capital, prepares the necessary economic analysis and the necessary engineering specifications and lets a contract for the construction job, operating the plant themselves after its completion; second, the company, or group of companies, owning the leases furnishes the necessary capital, lets contracts for the design and for the construction of the complete physical plant, and operates the plant after its completion; third, the company, or group of companies, farms out its gas-distillate leases or sells to another party and retires on an overriding royalty; fourth, the company, or group of companies, owning the leases furnishes capital for and supervises the field development; cycling interests furnish capital for and install and operate the cycling plant for some share of the recovery; fifth, the company, or group of companies owning the leases, furnishes gas to other parties who finance and install the plant, cycle the gas and store and load the recovered products for some predetermined flat charge per unit volume of gas handled.

Economic Analysis—The tax bill of a cycling plant may be an appreciable item if the plant capacity is excessive for the reservoir reserves, for in this case the yearly plant profits are at once partitioned by the Excess Profits Tax. State taxes on production from cycling plants are not uniform in application, but are being patterned after the present tax imposed on casinghead gasoline plants.

The distillate marketing situation, being relatively new of creation, should be very carefully investigated and conservatively discounted in forecasting future financial returns. As a minimum the total plant recovery might be sold at the prevailing crude oil pipe line price in the particular area; in some instances distillate sold to pipe lines receives a premium above the posted price of highest gravity crude. Many plant operators would prefer to dispose of their production directly to some responsible marketing organization, or in lieu of this, to sell it to

CHARLES D. PETERSON, formerly Chief Engineer of Fisher, now is District Manager with offices at Tulsa and he is available anywhere in the Mid-Continent for consultation on special control problems. His long experience is at your service in supervising and checking all applications of Control Equipment.

A Fisher Trained Engineer is available at VINSON SUPPLY COMPANY at all times and Five Fisher Engineers travel out of the Tulsa and Dallas offices—Giving a COMPLETE Sales and Installation Service.

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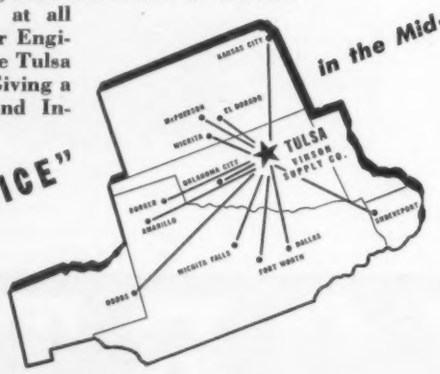

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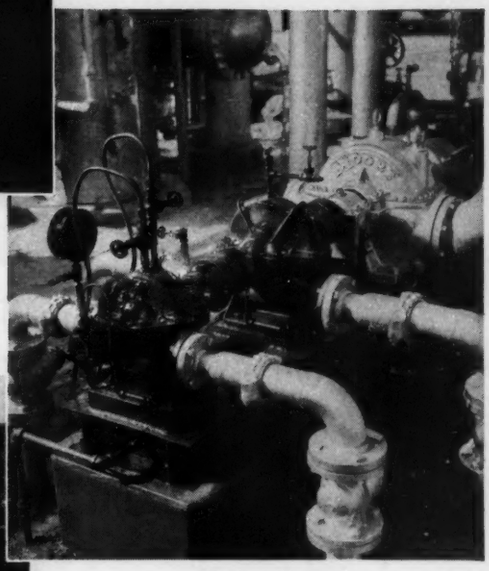
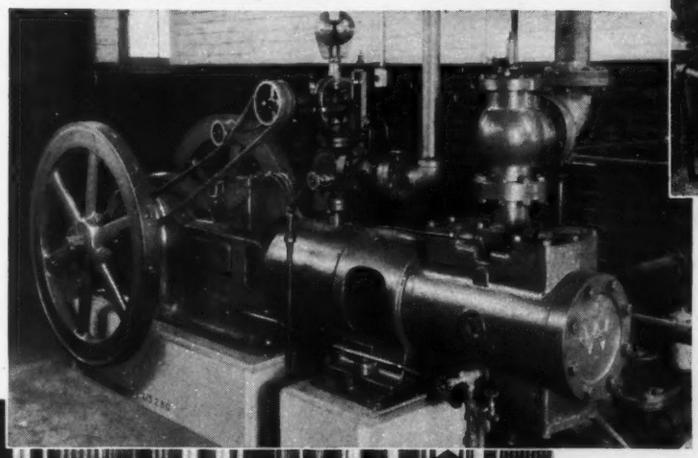
WORTHINGTON EQUIPMENT for NATURAL GASOLINE PLANTS

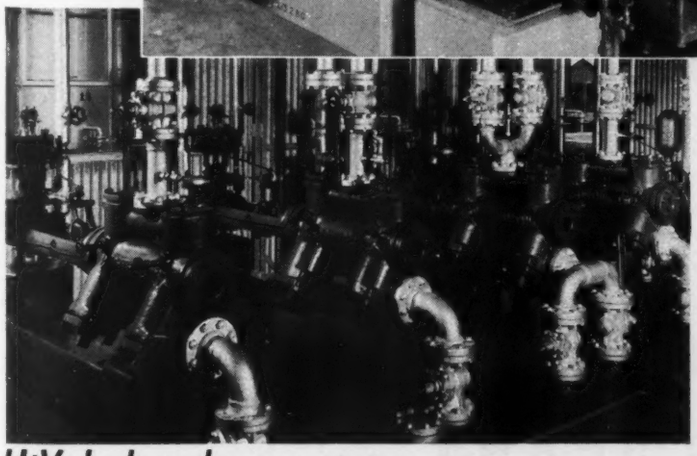
Worthington Angle Engine-Compressor . . . a typical natural gasoline plant installation



Centrifugal pumps . . . steam-turbine drive

Steam-driven compressor





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IC1-11

a pipe line outlet. In most cases, however, these operators cannot justify pipe line marketing because the material which they recover may be easily fractionated into commercial grades of gasoline, kerosene, and fuel oil, to bring a greater net price on the open market. An additional incentive for the plant operator to sell a marketable refined gasoline is the fact that his product is generally very susceptible to tetra-ethyl lead and for a relatively small investment in lead blending facilities his net income is increased and the number of possible market outlets is multiplied.

It would not be proper to conclude an economic analysis of a porposed cycling project without reviewing the engineering selection of size and design of the complete physical plant. The unit costs of development, plant and line installation, and operations, need to be correlated with the costs of taxes and the revenues from markets, advice on these latter two items being supplied by qualified persons. Such a review or correlation is best made in conference, at which time the intangible risk factors should be thoroughly discussed so that proper discount may be applied with reasoning and recommendations made for final disposition of the entire problem.

Conclusion

As has been indicated previously, all factors that make up the economic balance sheet of cycling operations can be determined with a degree of accuracy commensurate with any other type of oil field operation. Since this is the case, it is not prudent to hazard relatively large investments without first assembling the information necessary to completely portray any reasonable combination of circumstances that may enter into the economics of operation. The total cost of the preliminary investigation and the detailed engineering analysis is small. The cost of the unitization efforts may be appreciable, these expenditures varying in proportion to the number of interested parties that may be involved. Since the work required up to the point of unitization efforts is relatively inexpensive it logically follows that the process of establishing a cycling project can be made very orderly and investments kept to a minimum except as the project seems to develop and warrant the undertaking of activities which become very costly. Finally, the arrangements or commitments for field development and physical plant construction are not made until the success of the project is assured with at least that minimum of return that is acceptable to the financing agent or to the individual company policy.

Suggested Procedure in Developing a Cycling Project

Preliminary Investigation

A. Determine availability of sufficient reserves to justify further investigation.

B. Inspect possibility of unitizing acreage and royalties.

C. Examine contractual relations of all interested and involved parties.

D. Adopt some plan for centralizing authority to carry out detailed investigation and to complete project.

1. One field operator to assume complete charge.

2. Lease operators form engineering committee to assume complete charge.

3. Operators appoint engineering

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CHROME-IRON - CHROME-NICKEL

CASTINGS

with or without other alloying elements . . .

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1. Nineteen years experience in producing chrome-iron, chrome-nickel castings with or without other alloying elements.
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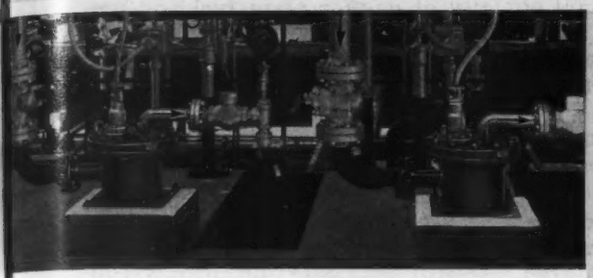
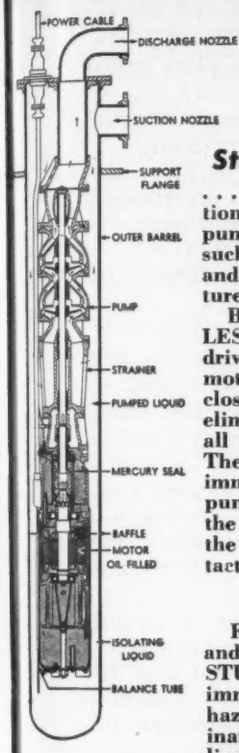
BYRON JACKSON Pump





The two STUFFINGBOXLESS Units above are in operation at a major refinery, handling a highly volatile hydrocarbon at 225 pounds suction, and 375 pounds discharge pressure.

Byron Jackson *Stuffingboxless Pumps*

. . . are designed for easy application to all services requiring the pumping of highly volatile liquids such as gasoline, butane, propane and similar liquids at temperatures not exceeding 150 degrees F.

Byron Jackson STUFFINGBOXLESS Pumps are electric motor driven pumping units, both the motor and pump being totally enclosed in a sealed barrel, thus eliminating all stuffing boxes and all contact with the atmosphere. The pump and special motor are immersed in the liquid being pumped, and are cooled by it, yet the bearings operate in oil, and the pumped liquid does not contact the active parts of the motor.

No Fire Hazard

For pumping Butane, Propane and Gasoline the advantages of the STUFFINGBOXLESS Pump are immediately apparent as the fire hazard is almost completely eliminated, and *no* loss of the valuable liquid can occur.

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Byron Jackson HYDROPRESS

The HYDROPRESS meets the difficult requirements when small capacities must be handled at high pressures, and it is rapidly displacing reciprocating pumps and standard centrifugal pumps previously used for such service. Vertical construction makes the HYDROPRESS compact, with resultant savings in space and with bearing loads reduced to a minimum. The multistage designs possible with vertical construction provide efficiencies seldom attained with pumps of similar size.

Ideal for Refinery Operation

Only one packing gland is needed in the HYDROPRESS, and since this single gland is subjected to suction pressure only, the stuffingbox difficulties invariably encountered with ordinary pumps are completely avoided. Other advantages include continuous, uniform, non-pulsating flow; variable capacities without by-pass or change of speed; and the elimination of relief valves. The HYDROPRESS is ideal for handling oil up to 900 degrees F.; capacities 10-250 g.p.m.; head range 200 to 10,000 feet.

The view at right shows shop assembly of a 200 H.P. HYDROPRESS to deliver 90 g.p.m. of gasoline at 5,200 foot head. Below at right: Detail of HYDROPRESS showing vertical split inner volute case surrounded by outer barrel, with pumped liquid at discharge pressure between inner and outer cases.

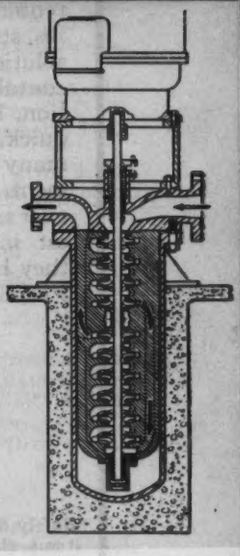
Bulletin Available

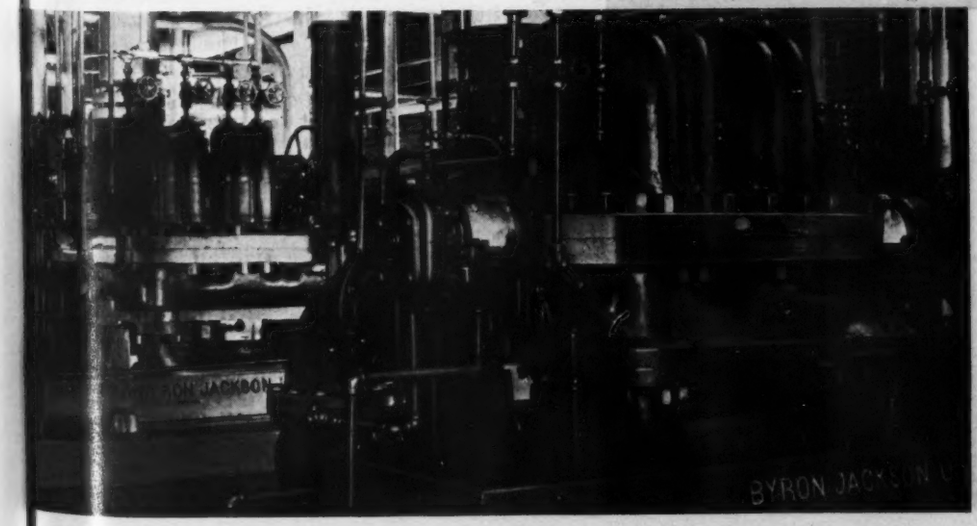
Ask for your copy of the HYDROPRESS Bulletin. If details of intended service are given, suggestions and recommendations will be sent without obligation.

The HOUDRY PUMP

The HOUDRY PROCESS presented an interesting pumping problem involving circulation of the heat transfer agent to the catalytic chests. The heat transfer agent used is a mixture of molten salts, at temperatures up to 850 degrees F. These molten salts are circulated to the catalytic chests for proper heat control. Structural requirements indicated the vertical type of pump, with the pump enclosed in a collecting chamber at the temperature of the salts, and the driver external to this chamber. The unit required an extremely long shaft, and the matter of expansion strains was highly important. As pumps are for circulation rather than for operation against high pressures, the heads are very low, but astonishingly large circulating capacities are required.

Byron Jackson HOUDRY PUMPS (as illustrated at left) solved this difficult problem—details upon request.





BYRON JACKSON MULTIPLEX PUMPS

The view at left shows modern Byron Jackson MULTIPLEX Pumps used in Dubbs Process operations at one of the world's largest refineries. The impeller arrangement and case design of these pumps limit pressure differentials across any close-clearance surfaces to 2-stage pressure. This special construction also completely balances hydraulic loads both radially and axially. The shaft is thus permitted to "float" rather than to be supported by stationary parts in the pump case. Ample provision is made for water jacketings of the stuffing boxes and bearings, thus insuring proper cooling with resultant long life.

Capacities range up to 75,000 barrels per day against pressures up to 1,200 pounds per square inch.

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Pumping Requirement

MONEY SAVING
News FOR REFINERIES
AND PRODUCERS

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To speedily clean trucks, tractors, engines, derricks, drawworks, spudders and other heavy refining or producing equipment, try steam cleaning with the NEW Oakite Steam Gun!

Used with Oakite cleaning materials, it cleans surfaces up to 12 feet high. No pumps, injectors, motor or elevated tank required. All you need is 30 lbs. steam pressure, steam and solution hoses and an open container for cleaning solution. Because this gun makes quick, easy work of cleaning many different types of equipment, refineries the country over say it is one of the shrewdest investments in economy they have ever made! Ask for FREE booklet giving details.

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firm to carry project up to point of routine plant operations.

4. Outside operating company to assume complete charge for a working interest.

Centralized authority to arrange for detailed analysis of project.

A. Engineering Analysis

1. Determine true distillate content of the reservoir gas and the characteristics of the recovered condensate.

2. Estimate total recoverable reserves.

3. Draw up plan for field development.

4. Determine size and type of plant best suited.

B. Unitization Analysis

1. Plan for unitizing operators.

(a) Type of unit to be formed.

(1-a) One unit for all acreage.

(2-a) Several units.

(b) Method of allocation of plant production to be used between units and between leases within each unit.

(c) Size and distribution of individual units and their relation to entire project.

(d) Agreement on method of operating project.

(1-d) One operating company to act as principal.

(2-d) Outside operating company to act as principal.

(3-d) Companies to act jointly through engineering committee.

(4-d) Companies to act jointly through outside engineering firm.

2. *Plan for unitizing royalty interests*

(a) Description of acreage involved.

(b) The right to co-mingle gas for processing and the right to inject dry gas anywhere on the structure.

(c) The method of allocating production between units, if more than one unit is organized.

(d) The method of apportioning production within the unit.

(e) A provision for reducing, or entirely eliminating, drilling obligations.

(f) A provision which will allow for the entrance of additional acreage to the unit on an equal sharing basis, or a provision which will permit the establishment of additional units, either of which provisions should set forth the minimum quantities of gas that must be processed for recovery.

(g) A provision for the sale of residue gas and the method of allocating income derived therefrom.

(h) A provision to allow the plant operator a reasonable quantity of gas for plant fuel and processing loss.

(i) An arbitration clause which may be invoked in the customary manner.

(j) A description of the methods of testing and measuring the distillate content for purposes of allocating or apportioning production.

(k) Reduction of royalty interests, if necessary due to low content, by:

(1-k) Agreement

(2-k) Selling gas to plant under separate ownership.

(3-k) Plant under separate ownership charges for processing.

(l) Rights-of-way for plant use.

(m) Method of determining prices of saved and sold products.

(n) Payment provisions.

(o) Outage and tax deductions.

(p) Warranty of title.

(q) Force majeure clause.

C. Arrangements for financing, constructing and operating plant

1. Company owning the leases furnishes the necessary capital, prepares the necessary economic analysis and the necessary engineering specifications and lets a contract for the construction job, operating the plant themselves after its completion.

2. Company owning the leases furnishes the necessary capital, lets contracts for the design and for the construction of the complete physical plant, and operates the plant after its completion.

3. Company farms out its gas-distillate leases or sells to another party and retires on an over-riding royalty.

4. Company furnishes capital for and supervises the field development; cycling interests furnish capital for and install and operate the cycling plant for some share of the recovery.

5. Company furnishes gas to other parties who finance and intall the plant, cycle the gas and store and load the recovered products for some predetermined flat charge per unit of gas volume handled.

D. Economic Analysis

1. Taxes.

2. Markets.

3. Economics of size and design of total physical plants.

a. Costs of total physical plants per unit of capacity.

b. Costs of operations per unit of capacity.

c. Costs of taxes

d. Revenue from markets.

e. Estimates of intangible risk factors.

National Defense Part Of N. G. A. A. Program

The role of natural gasoline and natural gas in national defense will have consideration in the opening session of the twentieth annual meeting of the Natural Gasoline Association of America, Dallas, April 23, 24 and 25. This will come the afternoon of the opening day, whose morning session will be devoted to reports of committees.

Both morning and afternoon sessions of the second day will be devoted to technical subjects. The buffet dinner and entertainment, which will be provided by the Natural Gasoline Supply Men's Association, will be held that evening.

One technical paper and the Operating Kinks Session will get attention in both morning and afternoon sessions April 25. The prizes will be awarded in the afternoon, which also will bring election of officials for the coming year.

The national defense theme will come after the address of George P. Bunn, Phillips Petroleum Company. Elmer Schmidt, Lone Star Gas Company, Dallas, will be the speaker on the subject, "Natural Gas and Gasoline in National Defense." At this session Dr. F. H. Dotterweich, Texas College of Arts and Industries, Kingsville, will have a paper, "Useful Products From Natural Gas." This will be a non-technical summary of the processes by which synthetic products can be made from natural gas. Economics of these developments will be reviewed.

The session Thursday afternoon will be devoted largely to high-pressure-gas handling. This phase of the program will have two papers: "Close Fractionation in the Manufacture of Special Products at Natural Gasoline Plants," H. W. Harts, Warren Petroleum Corporation; "Dehydration of High-Pressure-Gas Operations as Applied to Repressuring and Pressure Maintenance," R. A. Carter, Continental Oil Company. Discussion of the first paper will be by J. L. Gallagher, Sinclair Prairie Oil Company. Dr. George Granger Brown and Dr. Donald Katz, University of Michigan, will have prepared discussion on the paper on gas dehydration.

One subject under consideration by the technical committee will get attention in a paper for the Thursday morning session when C. E. Wharton and H. A. Montgomery, Hanlon-Buchanan, Gladewater, Texas, will offer "Low Temperature Fractional Analysis, Apparatus and Procedure." This will be the first public report of a standardization research project in which for more than a year 15 laboratories have been running comparative analyses on identical gas samples. Liquefied Petroleum Gas will be considered at this session by G. L. Brennan, Philgas Division, Phillips Petroleum Company, whose subject will be "Safety in Handling, Shipping and Marketing Liquefied Petroleum Gases." The Hanlon award will be presented at this time.

Two projects of the Technical Committee and a report of the Gas Testing Committee will be heard the morning of April 23. H. L. Oder, Cities Service Gas Company, chairman of the Gas Testing Committee, will give the "Revised Charcoal Testing Method." This method for determining the gasoline content of natural gas has been rewritten to give more reproductible results. Along with

The Look Box

"New Volume Correction Factors for Liquefied Petroleum Gases," C. R. Williams, Continental Oil Company, chairman of the Technical Committee, will review other work of the committee. "The Magnitude of Variables Affecting Accurate Reid-Vapor-Pressure Determinations," a project of the technical committee, will be given by F. M. Allen, Indian Territory Illuminating Oil Company. This will be a review of the research on sources of error in these determinations with simple laboratory experiments to show graphically the magnitude of these errors and how they may be eliminated.

The program is the work of a committee headed by T. R. Goebel, Shell Oil Company, Houston. Other members are H. H. Beeson, Sabine Valley Gasoline Company, Shreveport; George E. Edgett, Carter Oil Company, Tulsa; H. A. Ells, Cities Service Oil Company, Bartlesville; F. E. Fisher, Skelly Oil Company, Pawhuska; R. D. Gibbs, Union Oil Company, Los Angeles; and Allen T. Givens, Coltexo Corporation, Monroe, Louisiana. The complete program follows:

Wednesday Morning Session

"Revised Charcoal Testing Method," H. L. Oder, Cities Service Oil Company; Chairman Gas Testing Committee.

"New Volume Correction Factors for Liquefied Petroleum Gases," C. R. Williams, Continental Oil Company; Chairman, Technical Committee.

"The Magnitude of Variables Affecting Accurate Reid-Vapor-Pressure Determinations," F. M. Allen, Indian Territory Illuminating Oil Company.

Afternoon Session

President's Address, George P. Bunn, Phillips Petroleum Company.

"Natural Gas and Gasoline in National Defense," Elmer Schmidt, Vice President, Lone Star Gas Company.

"Useful Products from Natural Gas," Dr. Frank H. Dotterweich, of Texas College of Arts and Industries.

Thursday Morning Session

"Safety in Handling, Shipping and Marketing of Liquefied Petroleum Gases," G. L. Brennan, Philgas Division, Phillips Petroleum Company.

"Low-Temperature Fractional Analysis, Apparatus and Procedure," C. E. Wharton and H. A. Montgomery, Hanlon-Buchanan, Inc.

Presentation of Hanlon Award for meritorious service to the natural gasoline industry.

Afternoon Session

"Close Fractionation in the Manufacture of Special Products at Natural Gasoline Plants," H. W. Harts, Warren Petroleum Corporation.

"Dehydration in High-Pressure Gas Operations as Applied to Repressuring and Pressure Maintenance," R. A. Carter, Continental Oil Company.

Discussion by Dr. G. G. Brown, University of Michigan.

Evening

6:30 O'Clock—Buffet Dinner and Entertainment, Roof Garden, Baker Hotel. Compliments of the Natural Gasoline Supply Men's Association.

Friday Morning Session

Operating Kinks Session in which field, plant and laboratory men compete for substantial prizes with their own ideas for doing any job within their province in a safer, better or cheaper way. This session is a mine of information on unique and practical methods of operation.

"Compressor Losses Caused by Orifice Meters," V. E. Middlebrook and Jed Burham, Shell Oil Company.

Afternoon Session

Continuation of Kinks Session and discussions.

Presentation of Operating Kinks Prizes.

Announcement of new officers and directors.

CONVENTIONS

APR. 15–17	Southwest Gas Measurement Short Course, University of Oklahoma, Norman.
16–18	Western Petroleum Refiner's Association, annual meeting, Arlington Hotel, Hot Springs, Arkansas.
23–25	Natural Gasoline Association of America, annual meeting, Baker Hotel, Dallas.
23–25	Petroleum Industry Electrical Association, Mayo Hotel, Tulsa.
24–25	National Petroleum Association, Cleveland Hotel, Cleveland.
MAY 2– 3	Petroleum and Natural Gas Conference, Pennsylvania State College, State College, Pennsylvania.
5– 8	American Gas Association, Natural Gas Section, Dallas.
15–16	American Oil Chemists' Society, St. Charles Hotel, New Orleans.
19–21	American Institute of Chemical Engineers, Edgewater Beach Hotel, Chicago.
19–22	American Petroleum Institute, mid-year meeting, Mayo Hotel, Tulsa.
JUNE 1– 6	Society of Automotive Engineers, summer meeting, The Greenbriar, White Sulphur Springs, West Virginia.
16–20	Petroleum Division, American Society of Mechanical Engineers, Kansas City.
19–20	Pennsylvania Grade Crude Oil Association, annual meeting, Bradford, Pennsylvania.
23–27	American Society for Testing Materials, annual meeting, Palmer House, Chicago.
SEPT. 8–12	American Chemical Society, Atlantic City.
17–19	National Petroleum Association, Thirty-ninth annual meeting, Traymore Hotel, Atlantic City.
29–30	National Lubricating Grease Institute, Stevens Hotel, Chicago.
OCT. 16–18	American Institute of Mining and Metallurgical Engineers, Petroleum Division, Dallas.
31	California Natural Gasoline Association, Los Angeles.

Defense on WPRA General Program

For its general sessions of the twenty-ninth annual meeting, Hot Springs, Arkansas, April 16, 17 and 18, Western Petroleum Refiners Association has adopted a theme of national defense. As in the past technical sessions will be confined to morning programs and general subjects will come in the afternoons.

Willard Chevalier, publisher of Business Week, New York, will speak the afternoon of April 17 on "Business Under Arms." He was an officer in the engineering corps during the first World War and since has had experience in several lines of business. R. W. McDowell, Mid-Continent Petroleum Corporation, will review the industry since 1939.

The next afternoon Paul G. Hoffman, president of Studebaker Corporation, South Bend, Indiana, will have the subject, "The Automobile—Is It Lipstick or Lifeblood in our Defense Economy?" A second speaker that afternoon will be Professor Henry M. Busch, Western Reserve University, Cleveland, whose subject will be "America in a World at War." He will give special attention to the relation of petroleum and other materials to the political and strategic factors of military affairs.

Evenings have been reserved for entertainment. This will start April 16, when The Ethyl Gasoline Corporation will be host at a buffet supper in the Arlington Hotel, where all sessions will be held. Another buffet supper and Arkansas party will be held April 17. The annual dinner dance the evening of April 18 will close the meeting.

The program for both technical and general sessions follows:

Technical Session—Thursday Morning, April 17

W. M. Carney, Lion Oil Refining Company, presiding.

Introductory Remarks, L. D. Mann, chairman manufacturing committee.

Modern Trends in Lubrication—Wm. H. Oldacre, D. A. Stuart Oil Company, Chicago.

Trends of Lubricating Oil Manufacture and Utilization—Malcolm H. Tuttle, Max B. Miller Company, New York.

General Session—Thursday Afternoon

C. L. Henderson, Vickers Petroleum Company, presiding.

Opening Remarks, C. L. Henderson, president.

Washington Office Report—Fayette B. Dow, Washington counsel.

Association Report—J. C. Day, Secretary.

Review of the Petroleum Industry Since 1939—R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa.

Business Under Arms—Col. Willard Chevalier, publisher, Business Week, New York.

Election of board of directors and officers.

Technical Session—Friday Morning, April 18

C. W. Berger, Globe Oil and Refining Company, presiding.

Carbon As a Material of Construction for the Petroleum Industry—M. J. Dorcas, National Carbon Company, Cleveland, Ohio.

Synthetic Rubber—I. E. Lightbown, Standard Oil Development Company, New York.

Meeting of the board of directors.

General Session—Friday Afternoon

T. H. Barton, Lion Oil Refining Company, presiding.

The Automobile—Is It Lipstick or Lifeblood in our Defense Economy—Paul G. Hoffman, president, Studebaker Corporation, South Bend, Indiana.

America in a World at War—Henry M. Busch, professor, Western Reserve University, Cleveland, Ohio.

Report of committee on resolutions.

Gas Measurement Program Completed

The program for the seventeenth annual Gas Measurement Short Course, Norman, Oklahoma, April 15, 16 and 17, has been completed. The sessions are for the study of problems pertaining to the measurement and regulation of gas. All sessions are to be held in the engineering building of the University of Oklahoma. General sessions are held each morning. In the afternoons there will be classes dealing with special subjects and equipment.

Speakers and instructors for the classes are members of the faculty of the College of Engineering of the University of Oklahoma representatives of the oil, natural-gasoline and gas industries and engineers of manufacturing companies. The College of Engineering, University of Oklahoma, is sponsor of the course and is assisted by the Corporation Commission of Oklahoma, Railroad Commission of Texas, Kansas Corporation Commission, Oklahoma Utilities Association, Natural Gas Section of American Gas Association and Natural Gasoline Association of America.

The executive committee for the course is: Dean W. H. Carson, University of Oklahoma, chairman; Fay C. Walters, Panhandle Eastern Pipe Line Company, Kansas City; L. G. S. Heinberger, Sinclair Prairie Oil Company, Tulsa; Gilbert Estill, Oklahoma Natural Gas Company, Tulsa; E. E. Stovall, Lone Star Gas Company, Dallas; R. D. Turner, Skelly Oil Company, Tulsa; C. B. Day, Consolidated Gas Utilities Company, Dallas; George P. Bunn, Phillips Petroleum Company, Bartlesville.

The general committee is composed of chairmen of the following committees: R. L. Rountree, United Gas Pipe Line Company, Shreveport, general chairman; W. H. Carson, University of Oklahoma, entertainment; G. W. McCullough, Phillips Petroleum Company, Bartlesville, program; Miss Kate A. Niblack, Oklahoma Utilities Association, Oklahoma City, registration and publicity; R. M. Schofield, Lone Star Gas Company, Dallas, study of practical methods; C. A. Gibson, Cities Service Gas Company, Bartlesville, exhibits; Earl Kightlinger, Arkansas-Louisiana Gas Company, Shreveport, publications; Max K. Watson, Canadian River Gas Company, Amarillo, special bulletins; William F. Lowe, Natural Gasoline Association of America; E. C. McAninch, Oklahoma Natural Gas Company, Tulsa; W. R. McLaughlin, Pittsburgh Equitable Meter Company, Dallas; E. M. Myers, Corporation Commission of Oklahoma, Oklahoma City; J. H. Page, Kansas Corporation Commission, Wichita; F. V. L. Patton, Railroad Commission of Texas; E. H. Poe, Natural Gas Section, American Gas Association, New York; J. H. Satterwhite, American Meter Company, Tulsa; E. L. Stark, The Foxboro Company, Dallas; R. J. Sullivan, Humble Oil & Refining Company, Houston; C. E. Terrell, Southern Natural Gas Company, Birmingham; W. H. Woods, Gulf Oil Corporation, Houston.

The program has been arranged so some subjects can be continued or repeated in order to permit those interested to get advantage of subjects. The program follows:

Tuesday Morning

Registration — Engineering Building, Room 209.

General Assembly — Auditorium, Third Floor.

Presiding—R. L. Rountree, United Gas Pipe Line Company.

Introduction of Dr. W. B. Bizzell—R. K. Lane, President, Oklahoma Utilities Association.

Address of Welcome—Dr. Bizzell, President, The University of Oklahoma.

Introduction of General Committee—R. L. Rountree, United Gas Pipe Line Company.

Report of Committee for Study of Practical Methods — R. M. Scofield, Lone Gas Company.

Synthetics—Wm. F. Lowe, Secretary, Natural Gasoline Association of America.

The Natural Gas Outlook—E. H. Poe, Secretary, Natural Gas Section, American Gas Association.

The Gas Industry and the Job Ahead—T. J. Strickler, President, American Gas Association.

Tuesday Afternoon

Functions of Field Meter Men—J. R. Bird, United Gas Pipe Line Company.

Problems of Elementary Gas Laws—E. F. Dawson, The University of Oklahoma.

Velocity Type Pressure Control—D. B. Hutchcraft, Fisher Governor Company.

Operation of Recording Calorimeter—G. M. Arnold, Cutler-Hammer, Inc.

Gas Regulation and Blending—W. J. Beckett, Hanlon-Waters, Inc.

Large Capacity Displacement Meters—A. D. McLean, Pittsburgh Equitable Meter Company.

Domestic Meters—A. F. Benson, American Meter Company.

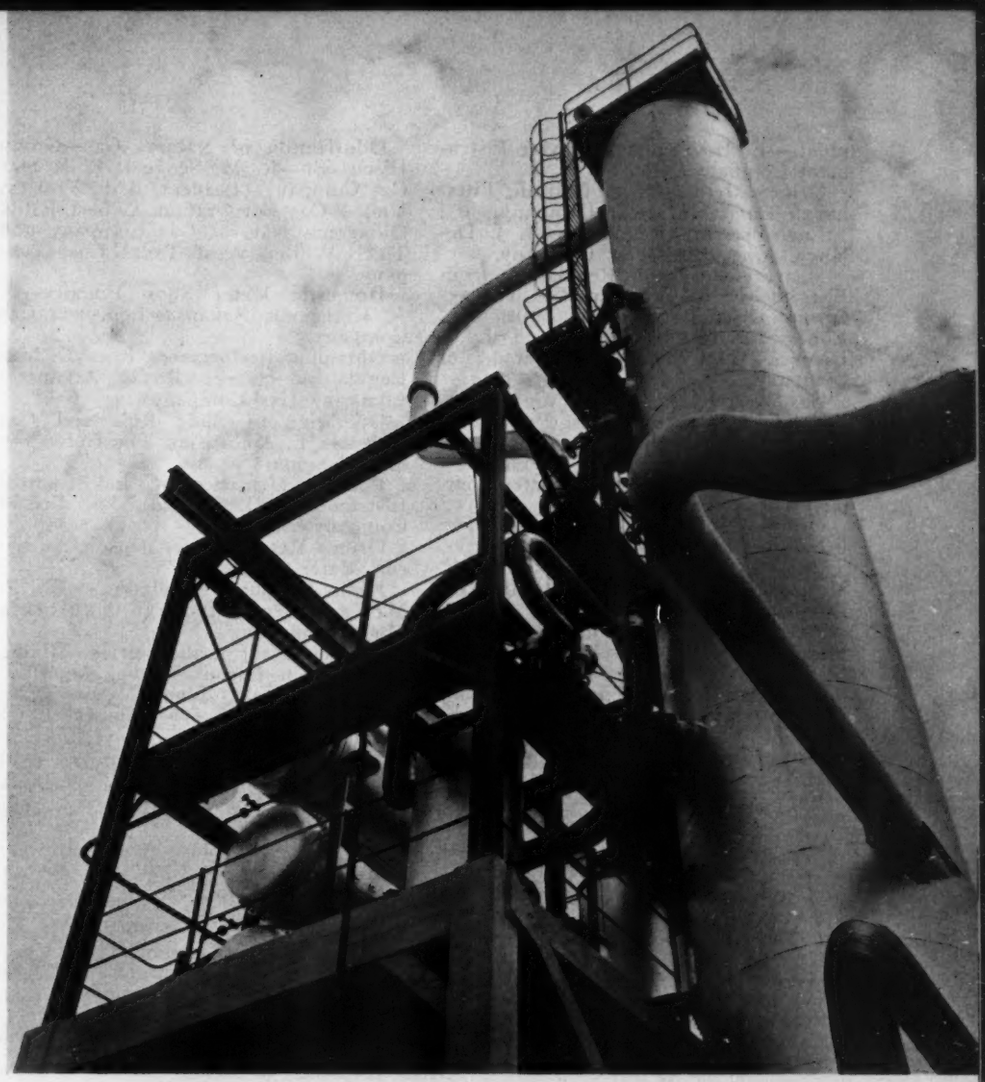
Measurement and Regulation from Extremely High-Pressure Gas Wells—Group Discussion—S. H. Smith, Jr., Lone Star Gas Company and J. C. Dennis, Tide Water Associated Oil Company.

Field Testing and Maintenance of Large Capacity Displacement Meters—J. P. McCarthy, Oklahoma Natural Gas Company.

Time Temperature District Gas Regulators—C. D. Peterson, Fisher Governor Company.

Operation of Flow Calorimeter—L. H. Cherry, The University of Oklahoma.

Recording and Controlling Instru-



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Isomerization will produce it.

1. Iso-butane is readily produced from normal butane for charging to alkylation units. Nearly all of the normal butane charged can be converted to iso-butane with a high conversion per pass.

2. The process is simple, involves inexpensive equipment, operates at moderate temperatures and pressures throughout.

3. Isomerization makes the alkylation process immediately available to the petroleum industry in cases where the ordinary supply of iso-butane is insufficient or too expensive.

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ments—E. H. Triphaus, Taylor Instrument Company.

Orifice Meters—J. L. Cottrell, Pittsburgh Equitable Meter Company.

Low Pressure Regulators—J. J. Delaney, American Meter Company.

Measurement and Regulation from Extremely High Pressure Gas Wells—Group Discussion—S. H. Smith, Jr., Lone Star Gas Company and J. C. Dennis, Tide Water Associated Oil Company.

Gas Accounting — Wet Gas Practices—C. L. Quast, Sinclair Prairie Oil Company.

Domestic Meters and Regulators—H. A. Kahler, The Sprague Meter Company.

Orifice Meters—L. K. Spink, The Foxboro Company.

Pilot Operated Regulators — E. C. McAninch, Oklahoma Natural Gas Company.

Automatic Flow Control — H. D. Meuffels, Reynolds Gas Regulator Company.

Low Pressure Regulators—M. D. Gilbert, Pittsburgh Equitable Meter Company.

Large Capacity Displacement Meters—H. V. Beck, American Meter Company.

Wednesday Morning

Fundamental Principles of Orifice Meters—A. D. MacLean, Pittsburgh Equitable Meter Company.

Fundamental Principles of Displacement Meters—A. F. Benson, American Meter Company.

Announcement of 1940 Prize Papers—R. L. Rountree, United Gas Pipe Line Company.

Wednesday Afternoon

Problems of Wet-Gas Measurement and Regulation—Group Discussion—M. S. Fales, Phillips Petroleum Company and C. L. Baker, The Texas Company.

Regulator Repair and Assembling Demonstration—W. R. Shiperly, The Chaplin-Fulton Manufacturing Company.

Fundamental Principles of Specific Gravity Determination—F. J. Renner, American Recording Chart Company.

Orifice Meter Field Problems—E. A. Thomas, The Foxboro Company.

Recording Instruments—A. G. Koenig, C. J. Tagliabue Manufacturing Company.

Large Capacity Displacement Meters—W. R. McLaughlin, Pittsburgh Equitable Meter Co.

Domestic Meters — A. F. Benson, American Meter Company.

Problems of Wet-Gas Measurement and Regulation—Group Discussion—M. S. Fales, Phillips Petroleum Company and C. L. Baker, The Texas Company.

Operation and Maintenance of Orifice Meters—C. E. Terrell Southern Natural Gas Company.

Chart Integration — J. L. Cottrell, Pittsburgn Equitable Meter Company.

Determination of Line Losses—High-Pressure Lines—R. J. Sullivan, Humble Oil & Refining Company.

Principles of Automatic Controls—E. E. Kleir, The Foxboro Company.

Gravity Balance and Gravitometer—H. F. Goodenough, The Refinery Supply Company.

Large Capacity Displacement Meters and Regulators — H. A. Kahler, The Sprague Meter Company.

High Pressure Regulators—J. J. Delaney, American Meter Company.

Odorization of Natural Gas—Group Discussion—R. M. Scofield, Lone Star Gas Company (Leader), B. F. Worley, United Gas Corporation, Gilbert Estill, Oklahoma Natural Gas Company and T. S. Whitis, West Texas Gas Company.

Domestic Meter Shop Practice—F. A. Kihneman, Arkansas-Louisiana Gas Company.

Obtaining Performance from District Regulators—H. F. Roux, Arkansas-Louisiana Gas Company.

Operation of Slide Rule and Gas Rule—E. E. Ambrosius, The University of Oklahoma.

Remote Measurement and Control Instruments—D. D. Ault, The Bristol Company.

Orifice Meters—A. F. Benson, American Meter Company.

High Pressure Regulators — W. R. McLaughlin. Pittsburgh Equitable Meter Company.

Inspection of Laboratories—Mixing of Gases in Porous Media, American Gas Association. Fluid Meter Tests, American Society of Mechanical Engineers.

Thursday Morning

Fundamental Principles of Regulators—K. R. D. Wolfe, Fisher Governor Company.

As a Commissioner Views It—Andrew F. Schoeppel, Chairman, Kansas Corporation Commission.

Thursday Afternoon

Back Pressure Tests of Gas Wells—E. N. Armstrong, Shamrock Oil & Gas Corporation.

Gas Accounting — Dry Gas Practices—J. L. Griffin, Northern Natural Gas Company.

Problems of Elementary Gas Laws—E. F. Dawson, The University of Oklahoma.

Regulators—R. H. Kaufman, The Chaplin-Fulton Manufacturing Company.

Domestic Meter Repair Demonstration—E. R. Gilmore, Pittsburgh Equitable Meter Company.

Orifice Meters and Rate Volume Controls—A. F. Benson, American Meter Company.

Operating and Maintenance Wrinkles for Metermen—Group Discussion—L. F. Carter, Colorado Interstate Gas Company (Leader), P. M. Childers, Continental Oil Company, P. H. Miller, Panhandle Eastern Pipe Line Company, G. E. Greiner, Phillips Petroleum Company and E. S. Doerr, Lone Star Gas Company.

Calculation of Meter Charts—C. F. Rittman, Jr., El Paso Natural Gas Company.

Regulators — H. D. Meuffels, Reynolds Gas Regulator Company.

Determination of Line Losses—Low-Pressure Lines—C. E. Halloren, The Gas Service Company.

Helpful Hints on the Installing and Operation of Regulators—C. D. Peterson, Fisher Governor Company.

Domestic Meter Repair Demonstration—E. R. Gilmore, Pittsburgh Equitable Meter Company.

Large Capacity Displacement Meters and Critical Flow Prover—H. V. Beck, American Meter Company.

Operating and Maintenance Wrinkles for Metermen—Group Discussion—L. F. Carter, Colorado Interstate Gas Company (Leader), P. M. Childers, Continental Oil Company, P. H. Miller, Panhandle Eastern Pipe Line Company, G. E. Greiner, Phillips Petroleum Company and E. S. Doerr, Lone Star Gas Company.

Determination of Specific Gravity (Different Phases)—C. T. Gill, Lone Star Gas Company.

Wide Range and Controlled Measurement—A. F. Benson, American Meter Company.

Reconditioning of Mercury—H. F. Goodenough, The Refinery Supply Company.

Low Pressure Regulators—M. D. Gilbert, Pittsburgh Equitable Meter Company.

Bell Prover Operation—H. V. Beck, American Meter Company.

Wilson Says Industry Ready and Cooperative

With the possible exception of tanker capacity for coastwise service, the petroleum industry is fitted to meet any demand it may face in the opinion of Dr. Robert E. Wilson, chief of the petroleum unit of the Office of Production Management. His statements before the Cole Committee of the House of Representatives March 27 was in sharp contrast to statements and reports previously issued.

He said the recent report of the National Resources Planning Board, which strongly urged regulation of the petroleum industry, had been prepared without consultation with the National Defense Advisory Commission or with officials of the Office of Production Management. This report of the National Resources Planning Board previously was sent by the President to Congress without recommendation.

Following his testimony before the Cole Committee Dr. Wilson was asked to give detailed testimony in secret hearing because of the possibility that his statistics and opinions might be of value to European nations.

In the public part of the hearing Wilson said of production:

"The production branch of the petroleum industry is today able to meet any increase in demand which may conceivably be made upon it."

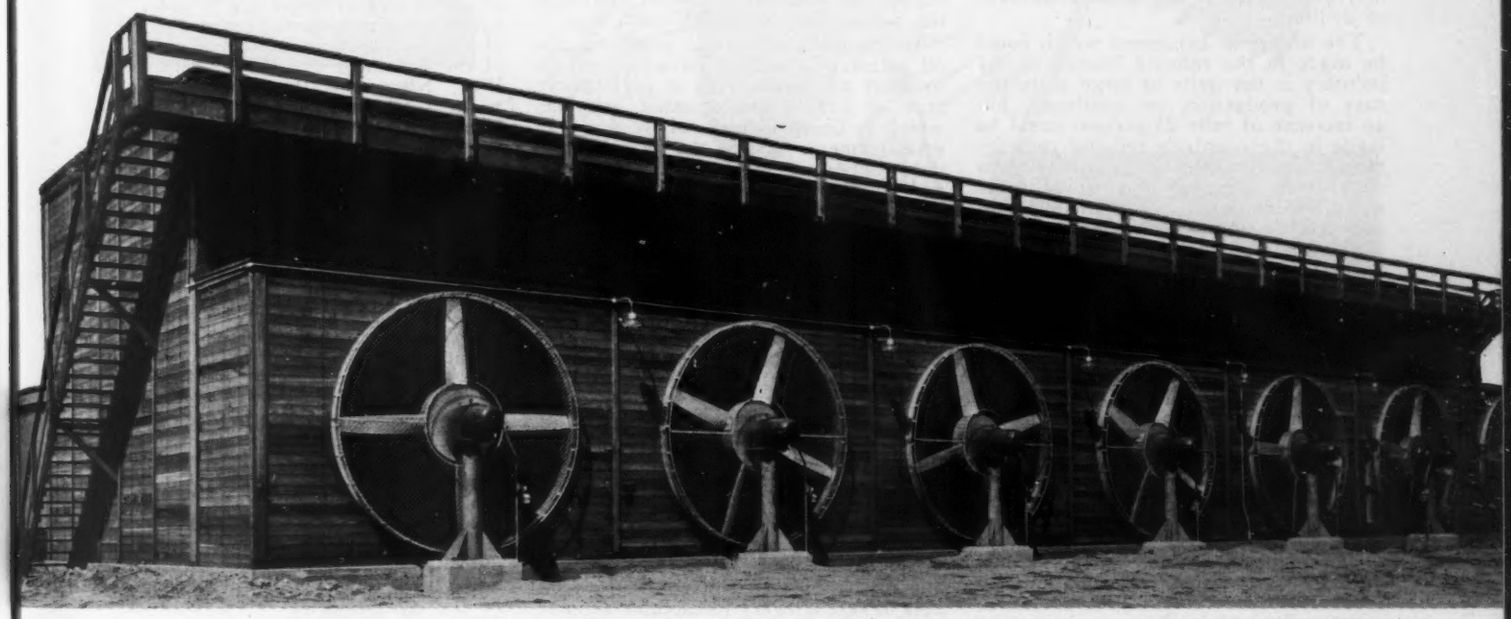
Concerning increase in demand for 1941 he expressed the opinion that it will be 8 or 9 percent higher than in 1941.

With respect to the military situation, he pointed out that the government's training program contemplates use of a substantial part of the planes and mechanized equipment and naval vessels now available, so that "the further increase in demand due to actual participation in war would not be nearly as large as would be calculated by figuring what all our military equipment would consume."

Percentage increase in demand for various products naturally differs, but on the whole, he said, "if we should become involved in an all-out war effort by the end of this year, the further increase in demand for the major petroleum products would be somewhere between five and ten percent" additional to the increase in civilian requirements.

"This figure," he explained, "may seem small in view of the obviously large demands of mechanized war and the difficulties this country experienced in meeting the great increase in demand

REFINERY PROCESSING



MECHANICAL DRAFT COOLING TOWERS

The demand for cooling water exceeds the supply in most refineries. The increased loads of new processing and greater output necessitate a greater supply of cooling water—available at all seasons regardless of climatic conditions. Low head, mechanical draft cooling towers will provide controlled cooling capacity and full production schedules.

With lower first cost and lower pumping charges than atmospheric towers, low head mechanical draft units pay their way by supplying cooling water on a year 'round basis.

Investment and operating costs are no greater than for atmospheric types. Less ground is needed; any position may be used regardless of wind access; and less water is lost.

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during the last war. It must be remembered, however, the petroleum industry's production of gasoline has increased about twelve-fold since 1916, and that our shutdown refining capacity today is much larger and more efficient than was the entire refining capacity of the country even in 1918. Also, there was then no large available reserve of shut-in crude production such as exists today."

30 Percent Increase Easy

As against the relatively slight increase in demand which is foreseen, he informed the subcommittee, it would easily be possible to make a 30 percent increase in our present high rate of crude production and continue this for a two-year period without any major new discoveries or any unusual amount of drilling.

The degree of expansion which could be made in the refining branch of the industry is not quite as large as in the case of production, he continued, but an increase of fully 25 percent could be made in the country's refining capacity merely by starting up capacity now shut down, although this would mean some reconditioning of old equipment and use of some relatively inefficient facilities.

He said, however, that the present shut-down capacity is greater and more efficient than the entire capacity of the industry at the close of World War I, but "to remain in this favorable position the refining industry must continue to build to keep pace with the growth of peacetime demand, and keep the reserve of 20 to 25 percent of shut-down capacity available for emergency demands."

Similarly, Dr. Wilson found, the ability to expand also exists in the field of transportation, with one special situation excepted, and a 20 percent expansion in the amount of crude and products transported by pipe lines could be handled on short notice and with little additional construction, while the same is true of tank car transportation in the interior.

"The only possible bottleneck which gives us concern is in tanker transportation to the East Coast," he explained. "About 95 percent of the petroleum products consumed by the east coast states is delivered there by tanker, either in the form of crude or refined products, and mainly from the Gulf Coast. The movement from the Gulf Coast alone amounts to about 1,250,000 barrels per day, and requires the services of a fleet of 260 domestic tankers. This large tanker fleet normally has some excess capacity, but a combination of circumstances has resulted in a rather tight situation at present.

"These circumstances are, first, the fact that a large percentage of our tanker fleet was built during and shortly after the last war, and hence is nearing the end of its useful life; second, during the past two years a considerable number of ships has been transferred into foreign service to replace ships which have been sunk and to make up for the longer hauls and less efficient use of tankers brought about by war conditions. In addition to this, eight large, high-speed tankers have already been requisitioned by the Navy and several more are likely to be so requisitioned, especially in the event of war. As a result, there has been some shortage in tankers during each of the last two winters when the peak demand for heating oils tends to create a shortage.

Emphasizes Pipeline Need

"In the event of a naval war in the Atlantic, which might result in the loss of some tankers and necessitate the use of a convoy system, there would undoubtedly be serious difficulty in supplying civilian requirements on the east coast and for this reason we have been urging the industry to relieve this situation by all possible means. Such means include the building of more storage on the Atlantic seaboard, so that reserve stocks can be built up and tankers can be used effectively during the slack season; the building of more tankers, 25 of which are expected to be delivered during this calendar year, and the building of any pipeline or barge transportation facilities which can be undertaken by private capital to help to supply the east coast without involving the tanker haul around Florida."

In the field of special products, the oil industry is making successful efforts to meet all needs. This is particularly true of 100 octane aviation gasoline, which is being turned out by some 18 establishments despite the fact that the construction of synthetic plants for its production is quite expensive, Dr. Wilson said. The industry already has constructed enough capacity to meet more than twice the present domestic and foreign demand and is building up substantial stocks, so that estimated requirements for at least the next 15 months can be met without further construction than that already announced.

The petroleum unit also has recommended that the Navy build up substantial reserve stocks of heavy fuel oil, particularly on the east coast, where there is much less available for emergency needs than on the Pacific, and has suggested designs for underground storage of both fuel oil and aviation gasoline.

"The petroleum industry has been, and in my opinion will continue to be, able to supply every foreseeable demand for petroleum and its products without requiring any government funds or advance government contracts," he said in summing up the current situation. "Of course, this statement does not necessarily apply to new construction required to help meet shortages in other industries, such as the production of synthetic toluene and synthetic rubber from petroleum.

"Not only can all military demands for petroleum products be met without difficulty, but there seems to be no probable necessity for any civilian curtailment, barring the possible shortage in transportation to the east coast which I have already mentioned. Substantial civilian curtailment in this country would not only be far more disruptive than it has been in Europe, but would deprive federal, state and local governments of much needed revenue at a critical time.

"Industry Is Cooperative"

"The industry has shown a very cooperative attitude in all its contacts with the petroleum unit, and has repeatedly indicated its willingness to do anything within reason to prepare to meet all defense needs as soon as they are informed with regard thereto."

Turning his attention to the southeast pipe lines, Wilson declared that from a standpoint of national defense they are "definitely desirable," and that "to permit one interstate carrier to block the right of way of another interstate carrier, especially under the emergency conditions we are facing, is indefensible."

In the event of an emergency which would slow down or cut off the tanker movement, the railroads and truck lines would be unable to carry the load. The southeast, he pointed out, is the only part of the country which now does not have the benefit of pipeline transportation, "and yet from a national defense viewpoint this is the most important place to have it in order to reduce the amount of tanker transportation required around the Florida peninsula.

"It seems fortunate that it is possible to have such facilities constructed by private capital if the legal obstacles can be eliminated," he commented. "It is difficult to understand the unwillingness of the Georgia legislature to pass the necessary enabling legislation in view of the recent united recommendations of the President and the Secretaries of War, Navy and the Interior, but it would seem that it must be based on a lack of appreciation of the seriousness of the situation."

Discussing the situation with members of the subcommitee, Wilson pointed out that Representative Carl Vinson introduced a resolution in the House on March 23 instructing the Secretary of the Navy to appoint a board of officers to investigate the matter and report to Congress, but added that Navy officials have been interested in the southeastern pipelines for many months and have kept in close touch with developments.

Under questioning by Lea whether he thought that, in the event Congress passed legislation permitting private corporations to acquire rights-of-way by condemnation, the pipe lines so made possible should be subject to government approval and control, the OPM official said he thought that was a question of law which he could not answer. In the case of crude lines required to link up new fields, he suggested, the length of time required for the formalities of securing a certificate of necessity might be embarrassing, but so far as lines for refined products are concerned, they are usually built only after considerable consideration and the time factor would not be so important.

Wilson Not in Accord with NRPB

Questioned by Chairman Cole regarding the National Resources Planning Board recommendations, Wilson said frankly that he was not in accord with them.

No member of the board ever consulted with the National Defense Advisory Commission or the Office of Production Management "and certainly not with the petroleum unit," he said.

While there can be no dispute with the board's assertion that petroleum products are essential to national defense, he added, "beyond that I cannot agree with the report."

There is no need for allocations, he contended, because the oil industry is one of the few in the country which "can take national defense in its stride and meet all possible demands upon it without calling for government aid," and super-imposition of federal control "at a time when private enterprise should be at a premium" would be highly inadvisable.

So far as the board's suggestion that up-to-date statistics should be compiled, he pointed out, the United States Bureau

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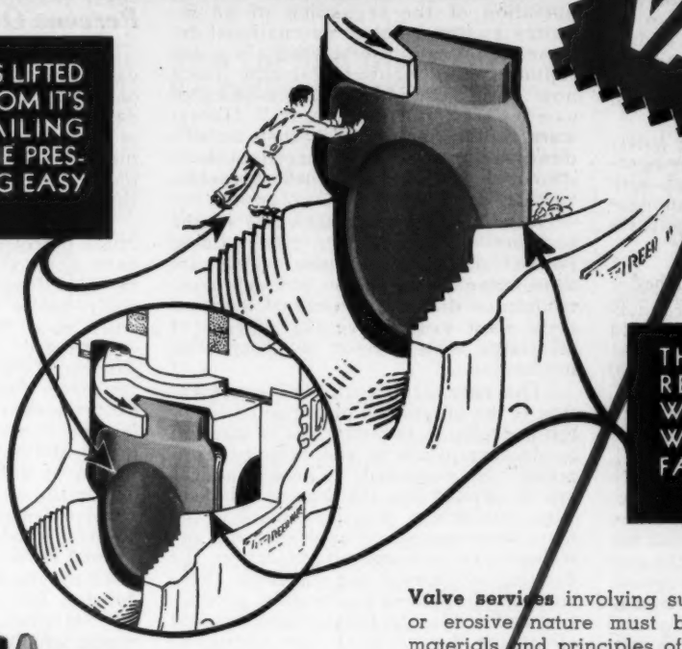

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of Mines alredy is doing that and the petroleum unit is studying defense requirements all the time, while its recommendation for creation of a federal oil conservation body overlooks the fact that an Oil Conservation Board already is operating and doing a good job.

So far as Illinois is concerned, he told Mr. Cole, that state injured itself more than it did the nation when it failed to adopt conservation laws. There was some waste of oil, he admitted, but it was slight and the greatest waste was in manpower and the construction of refinery capacity and pipelines. Today, Illinois production has passed its peak and is on the down-grade, and there is a strong probability that it shortly will adopt conservation legislation.

In that connection, he said the Interstate Oil Compact Commission is operating satisfactorily, but he agreed with Cole that participation in the commission's deliberations by federal experts would be desirable.

Military Requirements Established

Militarv requirements for oil products under an "all-out" war condition would total only about 125,000,000 barrels, or approximately ten percent of the 1940 output of 1,352,000,000 barrels of crude, the subcommittee was told March 28 by Major Clifford V. Morgan.

Army needs, Major Morgan said, would be 25,000,000 barrels, the figures for both Army and total military requirements being exclusive of aviation gasoline. The estimated requirement for 100-octane aviation gasoline, at the end of the present expansion program, would be 24,400 barrels a day, it was testified by Major D. G. Lingle, of the joint Army-Navy Aeronautical Board, who withheld more detailed information for submission in executive session.

Major Morgan estimated that the military (Army and Navy) needs for oil products would be 26,000,000 barrels of motor gasoline, 3,000,000 barrels of diesel oils, 100,000,000 barrels of heavy fuel oils, 1,000,000 barrels of lubricating oils and 150,000 barrels of kerosene.

He testified that he could see no need for the proposed southeastern pipe lines, since only a small part of the new army is located in that area. He was sharply called to task for his statement by Cole, who pointed out he was directly contradicting the Secretary of War, who had written the committee the pipe lines were highly desirable from a national defense standpoint.

Displaying a far more complete knowledge of the situation than had the Army representative, Rear Admiral H. A. Stuart, director of naval petroleum reserves, told the subcommittee the two proposed pipe lines were "highly desirable" from a military standpoint, although possibly not essential.

He made it plain, however, that the Navy department, which has gone on record many times as favoring "true" conservation, has little interest in either control or pipe line legislation from a military point of view.

Admiral Stuart said the department had nothing to add to the statement he made when he appeared before the subcommittee last year, and in answer to questions as to how the Pacific fleet would be provided for in the event of a war in which the Panama Canal was out of commission, assured the subcommittee that there are ample supplies on the Pacific coast to meet all requirements.

Industry Representatives Heard

With the official viewpoint received, the subcommittee turned its attention to the industry and heard an exhaustive report on the activities and policies of the Interstate Oil Compact Commission from J. C. Hunter, Abilene, Texas, one of a committee of three designated by Oklahoma's Governor Leon C. Phillips, Compact chairman, to represent the commission at the hearings.

"Any change in the now efficient operation of the regulation of an industry so important to our national defense would result immediately in a disruption of the smooth functioning which now brings confidence to the office of production management," Hunter warned. "Tampering with such an efficient machine by inexperienced mechanics could result in no benefit to public welfare."

Outlining the many activities of the compact commission, the witness pointed out that additional states are considering oil legislation, and expressed confidence that the conservation movement soon would have the support of all states with present or prospective production.

"The entire conception of conservation is the outgrowth of the activities of the petroleum industry itself through production practices and refinery technique," he explained. "These practices may be divided into two general subheads. The production practices involve the new development of exploring for petroleum reserves and after location, the drilling to recover the oil from these reserves. Improved exploration, production and drilling technique have brought about the discovery of vast additional petroleum reserves.

"In addition to this improvement in our ability to explore for petroleum reserves, secondary recovery methods have developed to the point that many fields heretofore recognized as exhausted or near exhaustion have been given new life, and through these methods we are now able to recover a far greater percentage of the oil from such reserves than was then considered possible."

Hunter declared the effect of the development of conservation laws "has necessarily been slow because the very nature of the political organization in this country is such that a period of education must precede the realization of legal expression."

"The compact commission has become a working example of the guidance and control of a most important industry in a truly democratic manner," he said. "Those who would supplant this commission with a more centralized control are answered by the effective performance and ever-increasing efficiency of the commission's work. The record of accomplishment of the commission is answer to such criticism."

Recommendations of the National Resources Planning Board for federal control and other steps were challenged by Hunter, who told the subcommittee that "no need has yet arisen, nor can we visualize any need, for such economic control with respect to petroleum resources.

"It has been the office of the compact to furnish a forum through which the states themselves are accomplishing every desirable proposal for the prevention of waste made by the national resources planning board," he declared.

"Most of these accusations of waste in the oil producing industry go back to periods before state-administered conservation, or to the time when this conservation was less efficient than it is today."

The subcommittee will resume its hearings April 1, at which time it will undertake a survey of the southeastern pipe line station.

Bureau Sets Demand Two Percent Over Year Ago

Jumping its estimates 53,000 barrels over March, the United States Bureau of Mines on March 21 forecast that a daily average supply of 3,709,300 barrels of domestic oil would be required to meet April demand. The month's estimate, it was reported, is 2 percent above the actual demand for April, 1940.

"The trend of demand for domestic crude petroleum in the first quarter has been approximately the bureau's forecasts, although exports have been materially below expectations and runs to stills have been greater," the report commented in reviewing the general situation "The strong domestic demand for motor fuel has absorbed part of the excess season production. The supply of heating oils has proved more than adequate, and imports of fuel oils have continued at a high level.

"On the whole, a better balance in the relative demand for the various products seems probable, accompanied by more normal refinery yields," it said. "On the basis of present available data, the total demand for all oils in the first quarter of 1941 may show a daily average increase of about three percent over the abnormally high demand in same period last year, and an increase of about five percent seems probable for the second quarter as compared to a year ago."

The bureau reported that daily average crude production during the four weeks February 8 to March 8 was 3,633,000 barrels, and runs to stills 3,577,500 barrels, while during the period domestic stocks increased an average of 140,000 barrels a day, indicating a demand of 3,493,000 barrels. This low demand was attributed to moderate runs to stills and low exports, with a plentiful supply of heating oil discouraging excessive refinery operation and the slowing down of marine transportation in winter materially reducing exports.

The domestic demand for motor fuel in April is estimated at 52,500,000 bar-

Bureau of Mines Forecast of Crude Oil Demand for April

State	Forecast April, 1941	Forecast March, 1941
Texas	1,355,300	1,327,400
California	596,300	596,400
Oklahoma	429,300	437,400
Illinois	336,000	335,200
Louisiana	299,700	291,300
Kansas	200,700	194,200
New Mexico	109,000	103,900
Wyoming	88,700	83,900
Arkansas	75,700	69,700
Pennsylvania	49,000	48,100
Michigan	44,000	47,700
Indiana	23,700	22,600
Montana	21,300	21,900
Mississippi	20,300	20,300
Kentucky	16,700	14,200
New York	14,000	13,000
West Virginia	11,000	11,100
Ohio	10,000	10,100
Colorado	4,300	3,900
Nebraska	4,300	3,200
	3,709,300	3,655,500

rels, an increase of 10 percent over the actual demand of the same month last year. The estimate for exports, based on forecasts by the principal shippers, is 1,900,000 barrels, compared with an actual export of 2,075.000 barrels a year ago.

Stocks of finished and unfinished gasoline amounted to 90,366,000 barrels on January 31, slightly lower than the abnormally high inventory on the same date last year and, according to statistics of the American Petroleum Institute, gasoline inventories increased about 6,000,000 barrels in February, which would bring stocks to about 96,400,000 barrels at the close of that month. The bureau estimates a decrease of 1,300,000 barrels for April.

Benzol production and direct sales of natural gasoline are estimated as 1,600,000 barrels, making an indicated refinery production of 51,500,000 barrels, distributed among the various refinery districts by the bureau, as follows:

East Coast, 6,490,000 barrels; Appalachain, 2,050,000 barrels; Indiana-Illinois, 11,290,000 barrels; Oklahoma, 2,690,000 barrels; Kansas - Missouri - Nebraska, 2,860,000 barrels; Inland Texas, 3,450,000 barrels; Texas Gulf Coast 12,540,000 barrels; Louisiana Gulf Coast, 1,460,000 barrels; Inland Louisiana - Arkansas, 950,000 barrels; Rocky Mountain, 1,410,-000 barrels, and California, 6,310,000 barrels.

Natural gasoline to be blended at refineries is placed at 6 percent of total refinery production, or 3,090,000 barrels. The yield of straight-run and cracked gasoline is estimated at 43.7 percent, which, applied to the production of 48,410,000 barrels, gives crude runs of 110,780,000 barrels, or 3,692,000 barrels a day.

The estimate for foreign crude runs to stills is 3,800,000 barrels compared with actual runs of 3,134,000 barrels in April, 1940.

The estimate for crude exports, in accordance with a distinctly pessimistic outlook among the principal exporters, has been lowered to 2,500,000 barrels, compared with 4,262,000 barrels in April of last year.

Crude oil to be used as fuel and losses is placed at 1,800,000 barrels, compared with 2,100,000 barrels estimated for the current month.

The total demand for domestic crude in April, as indicated by these estimates, is 111,280,000 barrels, or 3,709,300 barrels daily. Allocations among the producing states is shown in an accompanying table.

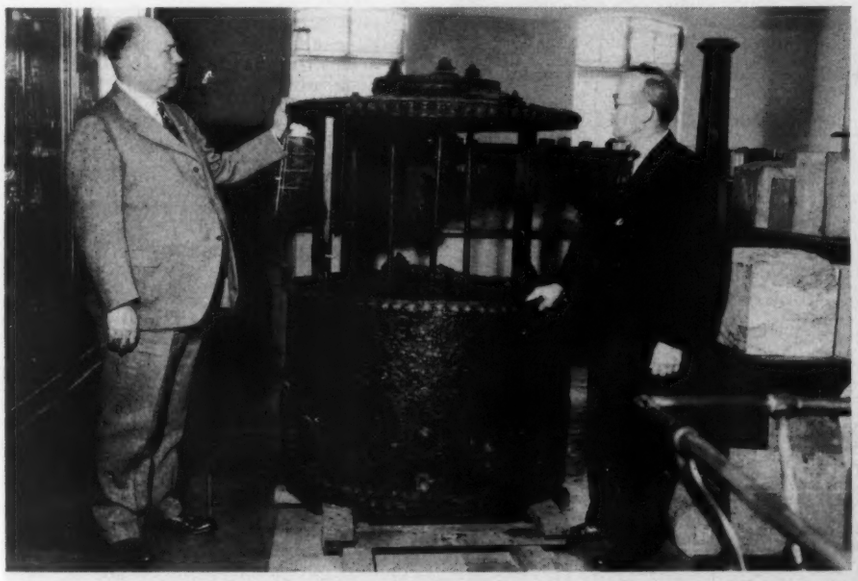
First Oil Still Given To College Museum

Into the museum of Pennsylvania State College March 20 went the "oldest petroleum refinery still in the western hemisphere." It was the invention of Samuel H. Kier, who in 1854 set it up as a means of separating an illuminating oil from oil seepages of what later became the first center of the petroleum industry in the United States.

History of the still has been given as follows by Pennsylvania State College:

"The Kier invention, which until recent months has lain rusting and disused in the Salina, Pennsylvania, brick plant of the General Refractories Company, which has been presented to the College, has been hailed as one of the earliest milestones in the development of a $14,000,000,000 industry. Some authorities refer to Kier as the 'grandfather of the American Refining industry' and 'the father of petroleum refining in the United States.'

"Kier first came into contact with petroleum in 1842 when he found the now valuable crude seeping from brine wells in Tarentum where his father and he operated a salt manufacturing plant. A continually growing flow of oil was interfering with the production of salt. By odor and sight it appeared to be not greatly different from the petroleum which at that time was believed to be a panacea for all human ailments. Kier



Joseph E. Moorhead, left, executive secretary of the Pennsylvania Grade Crude Oil Association, and Dean Edward Steidle, of the School of Mineral Industries, Pennsylvania State College, examine the industry's first petroleum still.

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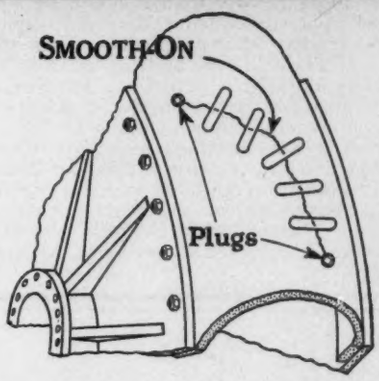

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had a chemist analyze it and was informed it was identical with the madicinal substance, so he preceeded to market the by-product for curative values.

"Within three years, however, it was discovered that the fluid was accumulating more rapidly than it could be sold and as a consequence Kier determined to see what other practical uses it might have. The still was built in an effort to refine the crude petroleum for use in illumination. It accomplished this purpose but the illuminant that was derived from it was so odoriferous that it was objectionable for use within the home.

"The first refinery was set up in Pittsburgh at the southeast corner of Grant Street and Seventh Avenue, where it occupied a one-story building about 12 by 24 feet. It had a daily refining capacity of six barrels.

"Pittsburgh soon became the important refining center of the world. In 1860 there were five refineries in the city and 3 years later there were 60 of these plants. Today, 80 years later, there are 32 refineries in Pennsylvania and the industry ranks second in value of manufactured products, being exceeded only by steel works products."

"After a few years of use at Pittsburgh the Kier still was transferred to Salina by a son of its inventor. None of his descendants followed in the oil business. A niece, Mrs. William M. McKee, Salina, Pennsylvania, has presented the museum with a bottle of the crude oil which her uncle offered as a medicinal remedy prior to setting up the still."

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C. N. G. A. Gadget and Kink Contest

Designated as the "C. N. G. A. Annual Gadget and Kink Contest," the May meeting of the California Natural Gasoline Association will be one of the most novel and interesting in the history of that body according to L. V. Cassaday, president. The event will be held at the Lebec Hotel on the Ridge Route half way between Los Angeles and Bakersfield on Friday evening, May 9, with a dinner at 6 o'clock to be followed by the meeting at 7:30.

All who have developed gadgets used in the natural-gasoline industry or who have developed operating kinks used in either office or plant procedure are invited to enter. This invitation is extended to members and non-members alike. There are no entry fees and cash prizes and other valuable awards will be given for winning entries.

The purpose of the meeting is to provide a means of bringing out gadgets and operating kinks where all may view the constructive work of others and where the individual with a gadget may have the opportunity to "get it over." Those concerned about protection of patent rights will find a simplified procedure has been arranged for such protection.

Anyone, excepting company officials, in the natural-gasoline, natural-gas or allied industries may enter a gadget or kink. However, gadgets already on the market are not eligible for entry. The committee in charge of the event has defined a gadget as being "a new device, tool, implement, part or piece of equipment designed to improve the doing of a job in a better, faster, safer, or more profitable way. An operating kink is defined as "a new or improved way of doing an old job by rearrangement or different use of existing tools, equipment or devices.

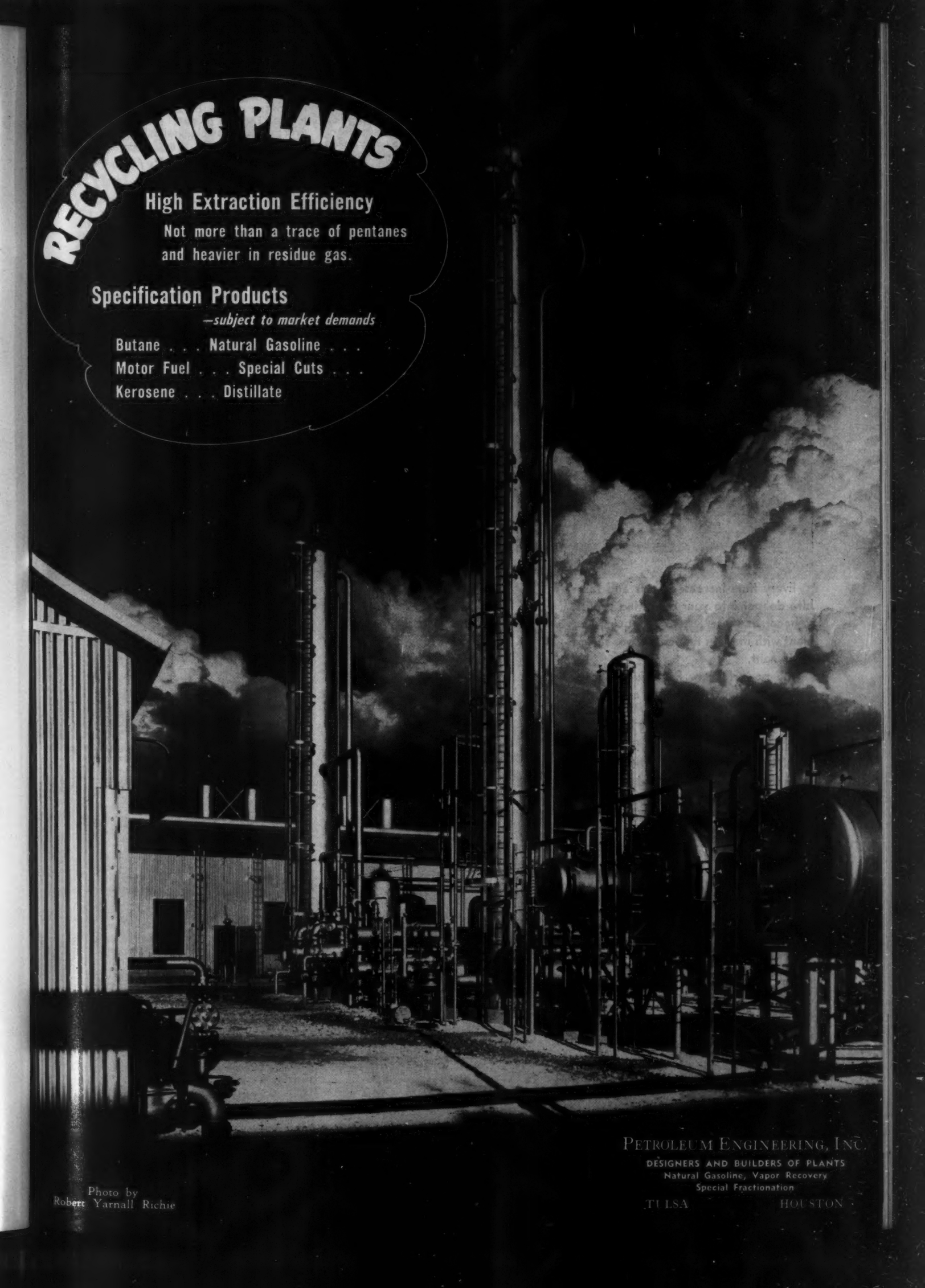
Those interested in entering are advised to communicate with George L. Tyler, Secretary, 510 West 6th Street, Los Angeles. An entry blank will be mailed and this should be filled out and returned with a good working drawing or sketch of the gadget or kink. Adequate facilities for display of gadgets will be available at the meeting.

Prizes will be awarded based on the scoring of five judges who will score on the basis of value, originality, adaptability, facility for constructing and practicability. The last day to file entries is April 30, 1941.

Committee Reports Blend Not Feasible

The power-alcohol idea, which has been under consideration for over 30 years, is no more practical today than it was at the beginning, the American Petroleum Institute's Committee on Motor Fuels reports in "Power Alcohol," a 68-page history and analysis of the proposal to require the admixture of grain alcohol with gasoline as a means of subsidizing the farmer. Since 1935 this committee has been studying all aspects of the proposal to utilize alcohol fuels.

The committee found that alcohol cannot be manufactured from farm products under present and prospective conditions for less than five to six times the cost of gasoline, and it asserts that a 10-percent mixture of alcohol with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gasoline would increase the nation's fuel bill by $690,000,000.

"Europe's experience with alcohol mixtures, instead of proving their value, as proponents have claimed, shows clearly that the scheme is not economically sound," the committee reports. "Because farmers buy one-fourth of the motor fuel consumed, because relatively few could actually sell products to alcohol distilleries, and because of the adverse influences on sales of other products, on soil fertility, and on independent farming, the net effect of the power alcohol scheme on farmers' interests would be adverse.

"Pretentions that alcohol is needed as a substitute for irreplaceable oil supplies are answered by the fact that petroleum reserves are greater today than ever before, while conservation methods are still improving rapidly. Also methods already developed of synthesizing oil from coal assure a continuing supply of oil as far into the future as any need can be forseen, at cheaper prices than are in prospect for alcohol."

Macmillen Officials Are Reelected

All officials of Macmillen Petroleum Corporation were re-elected at the annual meeting of stockholders in Los Angeles, March 5 as follows:

R. S. Macmillen, president; H. R. Macmillen, vice president and general counsel; M. P. Macmillen, vice president in charge of production; H. E. Boner, vice president in charge of refining; S. M. Batterson, vice president in charge of the El Dorado, Arkansas, plant; DeWitt Knox, secretary-treasurer; H. C. Burtch, assistant secretary.

Bureau Estimates Refinery Capacity Adequate for 1941

The United States "has ample refinery capacity to take care of any expected increase in demand for petroleum products in 1941," it was declared March 26 by the United States Bureau of Mines following completion of its annual survey of domestic refinery capacity.

Because of the importance of petroleum and its products to national defense, it was pointed out, the bureau's survey was carried through in record time to determine whether there is danger of a bottleneck in the supply of the major oil products.

The report showed that the total completed capacity of United States refineries increased two percent last year, from 4,628,646 to 4,718,969 barrels daily, and the number of plants increased during the year from 557 to 562.

The survey showed also that the total capacity of operating cracked-gasoline units at the start of this year likewise showed a gain of nearly six percent over January, 1940, with present total capacity of more than 1,000,000 barrels a day.

"Low gasoline prices, competition for crude-oil supplies, particularly in Illinois, and the termination of a favorable distributing arrangement for independent plants in the Los Angeles area forced the closing down of about 50 refineries during 1940," the bureau reported. "The number of operating plants accordingly declined from 461 on January 1, 1940, to 420 on January 1, 1941. These developments were also reflected in the capacity figures, the operating capacity declining from 4,196,694 barrels daily on January 1, 1940, to 4,180,588 barrels on January 1, 1941, and the inoperative capacity rising from 431,952 barrels to 538,381 barrels in the same period.

"Crude runs to stills are now averaging just under 3,600,000 barrels daily, indicating the effective utilization of 85 percent of the capacity in operation," the report continued. "The remaining 15 percent (nearly 600,000 barrels) appears ample to take care of any expected increase in demand during 1941. In addition, there are about 500,000 barrels daily of idle capacity, 80 percent of which was reported in 'good shape' the first of this year. As a further insurance against a shortage in output of refined products there were 141,225 barrels of crude-oil capacity under construction on January 1, 1941, about half of which was for replacement, and half was additional capacity. On the other hand, much of the inoperative capacity, while in 'good shape,' is incapable of meeting current specifications for products. Furthermore, a relatively large part of the unused capacity, both at operative plants and at idle plants, is in areas like California where it is least favorably situated to meet the expected increases in demand."

Reporting on the cracked-gasoline capacity, the bureau found 1,021,006 barrels of cracked gasoline daily at the beginning of the current year, with only 82,042 barrels of idle capacity, representing a somewhat lower propor-

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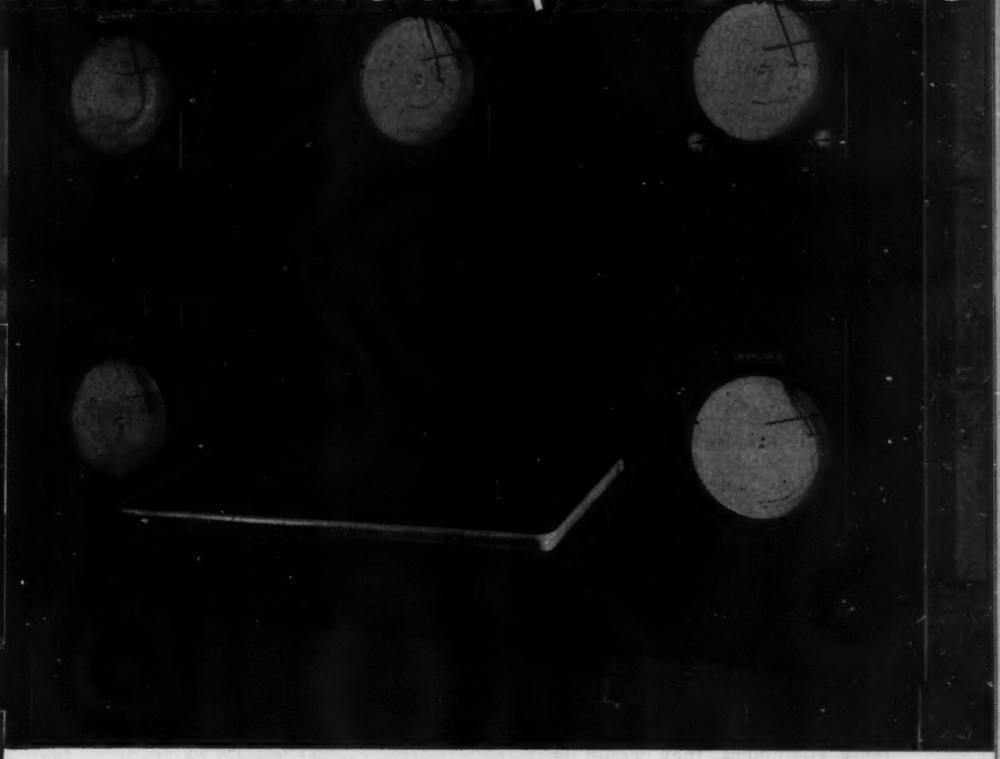
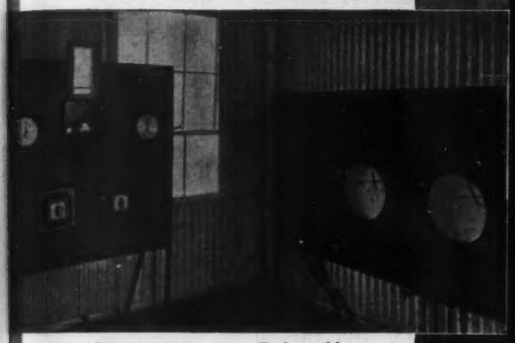
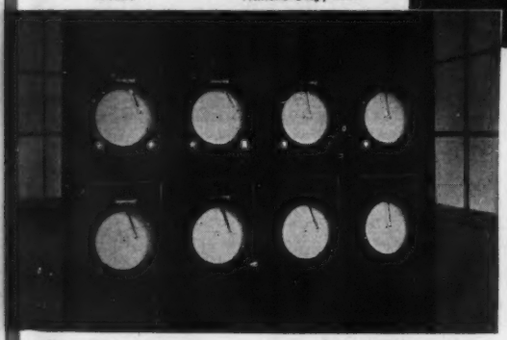




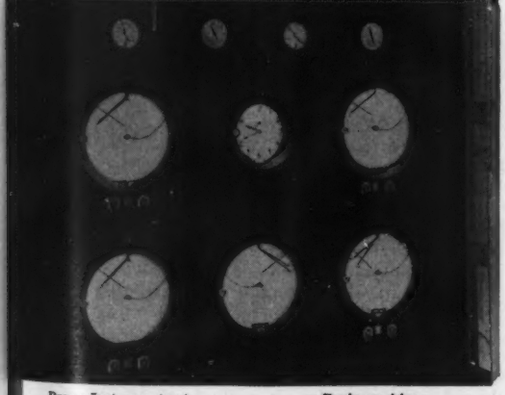
Brown Instruments at Tide Water Associated Plant

Engineered by J. F. Pritchard & Co. Kansas City, Mo.



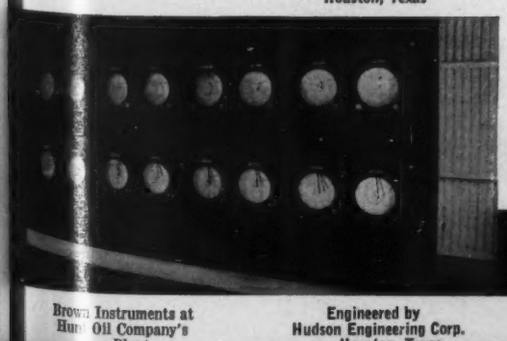
Brown Instruments at Coastal Recycling Corp.'s Plant

Engineered by Stearns-Roger Mfg. Co. Houston, Texas



Brown Instruments at Trinity Gas Corporation

Engineered by Hudson Engineering Corp. Houston, Texas



Brown Instruments at Hunt Oil Company's Plant

Engineered by Hudson Engineering Corp. Houston, Texas

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tion than with crude-oil capacity. Cracked-gasoline capacity under construction on January 1 totaled 48,145 barrels, compared with 58,075 barrels for the preceding year.

"As the present output of cracked gasoline is about 850 barrels daily," the report commented, "it follows that the operating ratio is about 83 percent."

Priorities Not to Affect Refining

Extension of the priorities system now gradually being adopted for important materials, under which production for defense is given right-of-way over that for civilian consumption, is not expected materially to interfere with operations in the oil industry, accepted as vital to the rearmament program.

Thus far, priorities have been imposed upon only two or three of the more highly important metals, but eventually it is foreseen that the system will be expanded to take in practically all materials entering into the production of defense needs, particularly those on which imports must be depended upon or of which domestic supplies are limited.

Manufacturers of refining equipment are said to be apprehensive over the effects of priorities but, while it could not be learned that that question has been under consideration, officials in Washington indicated that while such manufacturers might not get prime priority as producers of national defense equipment, they would be given secondary priority in order that gasoline production not only may be maintained but that groundwork is laid for any increase which may be necessitated by an emergency.

So far, the only action taken with respect to such equipment has been to place it on the export control list, to prevent shipments to "unfriendly" nations and conserve both the equipment and plans for improvements thereof for our own use.

It is admitted in some circles that the equipment manufacturers may encounter some difficulties in securing particular raw materials, but it was said that problem would be worked out between members of the industry and officials of the Priorities Division of the Office of Production Management, headed by E. R. Stettinius.

The administration still is hopeful that the defense program can be carried out side by side with ordinary civilian operations, having in mind the great desirability of maintaining commercial business so as to cushion the shock and dislocation which will follow the cessation of war production. The chief aim of the priorities system to provide adequate supplies for the defense industries is, if possible, to be attained without eliminating civilian production or, at most, to curtailing that which is least essential.

The oil industry is seen in Washington as being in a preferential position because of the importance of the commodity to the national defense and its probably equal importance to production for national defense by other industries, and there appears to be no desire anywhere in the administration to curtail the normal activities of any branch of the industry, without which production for defense would become prohibitively expensive.

Power Commission Questions Gas Use Effect on Oil

Fears that the rapid expansion of natural gas consumption may threaten the nation's oil supply were voiced March 24 by the Federal Power Commission, with the suggestion that Congress amend the natural gas act to give it the power to solve conservation problems, enabling it to exercise a measure of control over the petroleum industry.

The commission's views on the question of natural gas were made in its twentieth annual report, in which it pointed out that it has before it an application for a certificate permitting construction of a 1500-mile pipe line from South Texas to New York which will be capable of delivering 250,000,000 feet a day.

"This first proposal to tap the southwestern reserves of natural gas to supply the tremendous markets available in the northeastern states poses the country with a serious problem of energy resources conservation," it was declared. "The natural gas act as presently drafted does not enable the commission to treat fully the serious implications of such a problem."

The major question involved, the report continued, is whether the proposed line would not result in displacing a less valuable fuel and create hardships in the industry already supplying the market, while at the same time rapidly depleting the country's natural-gas reserves.

"There is an even more important question which should be answered before government sanction is given to large scale delivery of natural gas to the great eastern industrial areas," Congress was told. "That is the question as to whether rapid depletion of the country's natural-gas reserves may not reduce for all time the country's potentially recoverable reserves of oil.

"In view of the tremendous importance of petroleum products in both peace and war, it would be a grave mistake to allow the quest for quick profits and temporary convenience to cut into our available petroleum supplies.

"The commission is convinced that these conservation problems are of such pre-eminent importance, especially in the present world situation, that the natural gas act should be immediately broadened to give the commission power to resolve them in the public interest."

The report explained that while estimates of the known natural-gas reserves range from 60 to 75 trillion feet, the "generally accepted" figure is 66 trillion feet, of which 51.5 trillion feet is in the central and southern states, 7 trillion in California, 6 trillion in the eastern states and 1.5 trillion in the Rocky Mountain states.

"At the present time the rate of consumption of this commodity approximates 2.4 trillion cubic feet per year for all purposes," it was stated. "At this rate of withdrawal, the estimated total volume of reserves would last approximately 27½ years. However, the actual life of the country's natural-gas reserves cannot be definitely fixed in view of the fact that on the one hand new fields are continually being discovered and developed while on the other the market for natural gas is rapidly expanding."

The report pointed out that the commission now has jurisdiction only over proposed new pipe-line construction where the new line will enter a market area already being served by another natural-gas company, which prevents any serious effort to control the unplanned construction of pipe lines with a view to conservation, and recommended that the act be broadened to give it control over all new interstate natural-gas pipe-line construction. It urged also that the commission be given regulatory authority over rates on gas sold for industrial as well as domestic and commercial purposes.

A. S. T. M. Standards For Refractories

The 1940-1941 edition of this widely used compilation presents in their latest approved form all of the A. S. T. M. specifications, tests, and definitions covering these materials and gives considerable other information and data significant in the field of refractories. This edition supersedes the one published in 1937 and includes considerable additional material.

There are five specifications providing quality requirements for refractories for various services: boiler service, incenerators, malleable iron furnaces and also covering ground fire clay, and there are two classifiications covering fireclay refractories, and insulating block and insulating fire brick. The fifteen standardized testing procedures, comprising a major portion of the publication, cover such matters as pyrometric cone equivalent, panel test for resistance to thermal and structural spalling of refractory brick, permanent linear change, load test, cold crushing strength, warpage, porosity, particle size of ground materials, and methods of chemical analysis. Also given is a recommended procedure for calculating heat losses through furnace walls. There are standardized terms covering refractories and symbols for heat transmission.

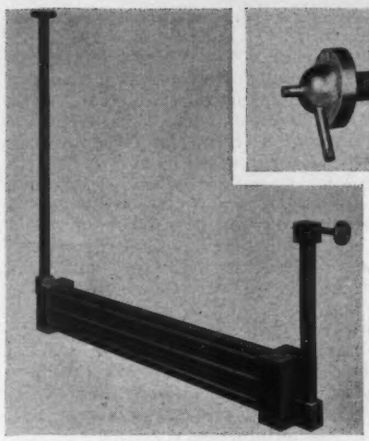
One of the most valuable activities of the Society's Committee C-8 which sponsors this Manual has been the development of industrial surveys of refractory service conditions, each one prepared by a competent authority in the industry. There is now a total of nine included. The 65 pages devoted to these surveys incorporate a great wealth of valuable technical information. The surveys cover the following: Openhearth practice, malleable iron, copper, and lead industries, by-product coke ovens, lime burning, glass, and portland cement industry, and stationary steam boilers.

Another feature of the compilation is information on standard samples of refractory materials, some eight standard samples being covered.

Copies of the manual are available from the American Society for Testing Materials, 260 South Broad Street, Philadelphia, single copies in board cover, $1.50 each, cloth $1.75 each. Reduced prices apply on orders of 10 or more copies.

John T. McCoy On API Committee

John T. McCoy, Tide Water Associated Oil Company, Bayonne, New Jersey, has been named a member of the refinery technology committee of the American Petroleum Institute.



Immersion Type Heat Exchanger

Bayonet Type Heat Exchanger

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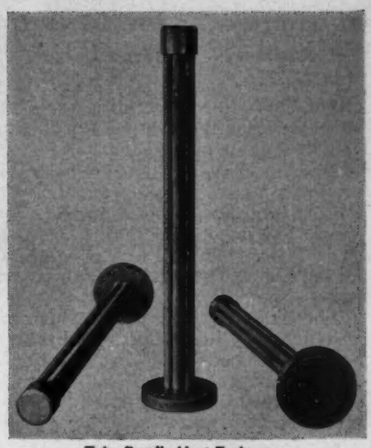

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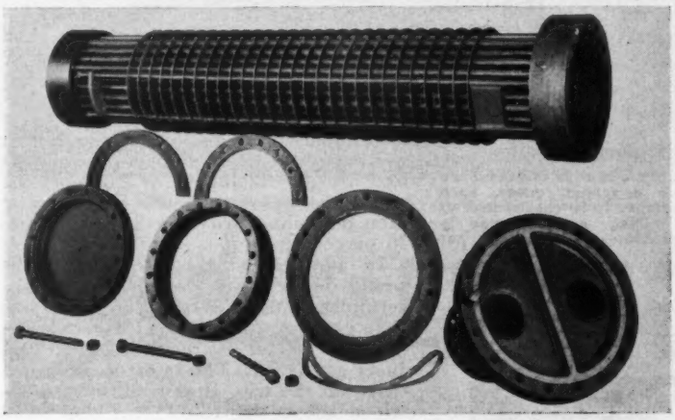
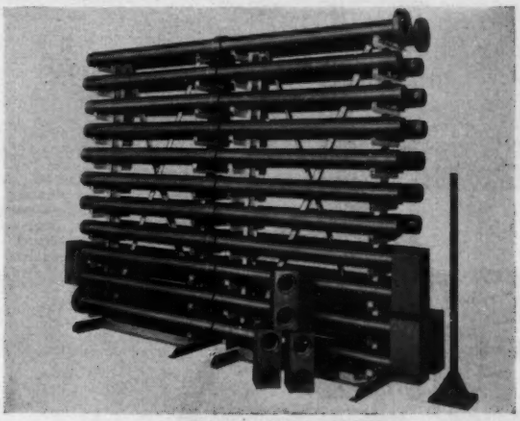


Elements for Shell and Tube Type Heat Exchanger



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Sweden Finds Producer Gas Economical Motor Fuel

Producer gas, made directly from either charcoal or wood, is rapidly substituting gasoline as fuel for the motor vehicle traffic in Sweden.

The wood fuel costs about 26 percent less than gasoline at prevailing prices. One of the big features of the development is that every combustible material such as weed, brush and possibly straw might also be utilized as fuel for farm tractors and trucks.

The war has necessitated this change. When hostilities broke out in September, 1939, Sweden had in operation 280,000 motor vehicles of all types. The greater portion of these had to be laid up for lack of gasoline. There being no restriction on the use of wood or charcoal, many trucks resorted to the use of producer gas, derived from charcoal, as was done in the first great war.

Charcoal is made from wood, preferably in dry condition. In Sweden, fairly large quantities are produced each year, usually from slabs, tree tops and waste, surrounding the lumber industry. When charcoal was again required as fuel for the motor vehicles, the supplies were soon exhausted, and no cheap, dry wood supply was readily available. Nothing else was left except plain, green wood.

The equipment used in the first great war, to facilitate the use of producer gas, had in the meanwhile been greatly improved. It was soon found that wood, cut into small cubes of about two inches, served almost equally as well, though the rate of burning being more difficult to control.

The use of wood directly is the outstanding and rather startling development, there being no scarcity of wood, and furthermore, useless, crooked and twisted pieces, could be used. Already 35,000 motor vehicles, mostly trucks, have been equipped for use of producer gas as fuel. Many more are ready to become so as soon as equipment can be got ready. To serve these with supplies of wood, or charcoal, new depots are springing up all over the country along the highways, and a great number of people are finding new and profitable employment.

The equipment consists in the main of a retort, placed on a trailer behind the vehicle. The retort, somewhat similar to the tub of a washing machine, thought larger, has a lid on top, for refueling, which is kept tight. There is a slow draft allowed from the bottom, and the gas and smoke produced from the burning of the wood, or charcoal, in the retort, is sucked into the engine by way of a tube. Evidently the only change to the engine equipment is a new or altered carburetor.

The above information is gathered from articles appearing in a Swedish road journal called "Svenska Vagforeningens Tidskrift." In an article in this paper written by Sten Gyllensverd, civil engineer, the contributor describes a trip by car, using charcoal as fuel, in which he himself took part.

"The trip was made in the summer of 1940, in an ordinary six-cylinder, two-door car, with three passengers and one dog. The start was made from Halmstad in the south, and contacted Trollhattan, Karlstad, Rattvik, Falun, Orebro, Johkoping and back to Halmstad, a total distance of 1859 kilometers, or 1161 miles. The fuel consumption for this distance was 24¾ hectoliter charcoal, or 75 kilometer per hectoliter of fuel. One hectoliter is 100 liter, and one gallon is 4.54 liter. Thus one hectoliter is about 22 gallons.

"The cost of charcoal was five kroner per hectoliter, or $1.25. This average to 6.67 ore per kilometer, or 2.6 cents per mile. The gasoline would have cost at then prevailing prices in Sweden, about 26 percent more."

In addition to the above data, the writer of the articles states that no discernible quantity of lubricating oil had been used on the trip, since a very small quantity of oil is required with producer gas as fuel. The retort was cleaned twice on the trip. Best results were obtained when the retort was kept well filled with fuel. Each filling required from one to three hectoliter, and 13 fillings were made. Rough roads, with down-hill slopes, assisted the burning of the fuel and thus increased the effective power of the engine. The average speed made was 46.4 kilometer per hour, or 29 miles.

Koch Reelected Kendall President

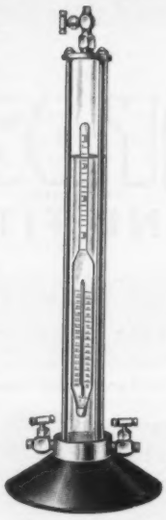
Otto Koch, Bradford, has been reelected president of Kendall Refining Company. Other officials reelected at the meeting of directors last month are: J. B. Fisher, executive vice president and secretary; J. H. Bovaird, vice president; S. J. Brill, assistant secretary and assistant treasurer; H. W. Jackson, assistant secretary and assistant treasurer.

Testing Apparatus for the Oil Industry

The trade-marks **AC-ME and R.S.** on laboratory apparatus, gas testing equipment, gasoline testing apparatus, and on oil testing instruments, identify them as products of the **Refinery Supply Co.**, the Southwest's leading manufacturer of this type equipment.

Besides the items carried under the above names, we carry an abundant stock of supplies manufactured by the leading manufacturers in related scientific fields.

Our special service department is equipped to handle all small, precision machine work.



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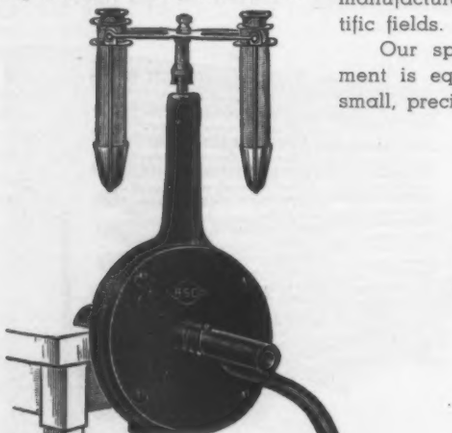
For accurately recording the specific gravity of gases. No complicated rotating parts — automatic compensation—rugged construction requires minimum of maintenance.



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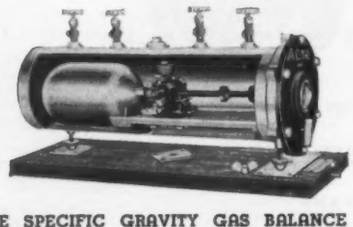
Redesigned for increased durability and efficiency. Safety tube holders prevent tubes from bursting or injuring operator. Maximum speed 2500 r.p.m. Complies with A.S.T.M. D-96-35 and A.P.I. Code No. 25. Five sizes available.

R.S. PRESSURE HYDROMETER JAR

The purpose of this apparatus is to permit the testing of liquefied petroleum gases, such as propane and butane. It is constructed of transparent Lucite tubing, and is made to stand operating pressures of 200 lbs. per square inch.



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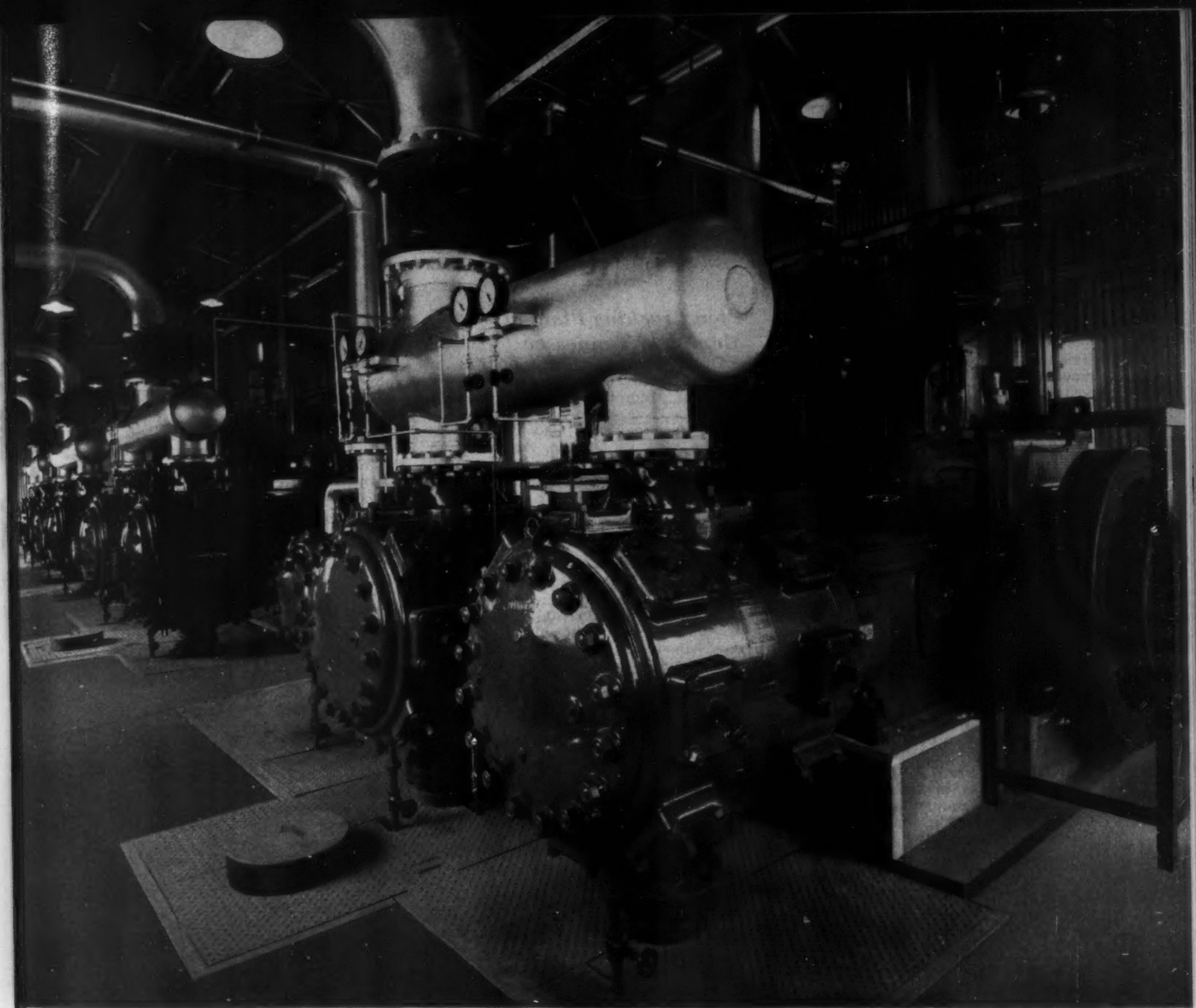

4 CLARK 400 H. P. "Angles", Warren Petroleum Corporation Natural Gasoline Plant, Salem, Illinois. Fifth unit not in photograph.

A *Leader* CHOOSES CLARK "ANGLES"

Another leader in the Natural Gasoline Industry has chosen CLARK "Angle" Compressors for natural gasoline production. Warren Petroleum Corporation's new plant at Salem, Illinois, is equipped with five 4-cylinder 400 H. P. CLARK "Angles". This plant is handling 22,000,000 cubic feet of gas daily, from which more than 80,000 gallons of liquefied petroleum products are being produced.

In a little more than 4 years on the market, approximately 76,200 horsepower of CLARK "Angles" has been sold for natural gasoline service, while a total of 340,000 horsepower has been sold for all purposes—a new world record for compressor sales. The reasons for this success are the economies which this unit has introduced: (1) Lower transportation and erection costs; (2) Smaller foundations and floor space; (3) One-third fuel saving, due to CLARK patented fuel injection; (4) Lower maintenance due to mechanical simplicity. Our engineers will be glad to consult with you.

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CLARK

Rear View of four CLARK 400 H. P. "Angle" Compressors. Fifth unit not in photograph.

▼ PLANT ACTIVITIES ▼

Atlantic Announces Large Expansion Program for 1941

The Atlantic Refining Company, in the annual report of President Robert H. Colley to stockholders, last month announced a $7,750,000 refinery expansion program for 1941.

Largest item on the program is a plant for manufacture of 100-octane aviation gasoline at the Point Breeze refinery. Construction is to start late this year.

"The plant will round out our facilities and enable us to contribute our full share to the national-defense effort," Colley said. "It is important for our national welfare, not only that the military be supplied with unstinted quantities of products of the highest quality but that the supporting plants catering to the material welfare of the civilian population should not be impeded in their activities by restrictions in the use of petroleum products."

Other items on the expansion program include a new catalytic cracking plant to supplement a new catalytic polymerization plant at Point Breeze, and a new unit for the refinery at Atreco, Texas. Construction is scheduled to start on a new crude-oil distillation unit complete with desalting, catalytic desulfurization and hydrogen sulfide disposal equipment.

The company's $1,300,000 terminal at Fort Mifflin, on the Delaware River, is scheduled for completion this summer. Comprising a dock, four 80,000-gallon storage tanks and two 5-mile 16-inch pipe lines leading to the Point Breeze refinery, it will facilitate receipt of crude oil. Three tankers are planned, the first for delivery in the fall of 1941, the second in the spring of 1942 and the third early in 1943.

New Tide Water Unit Near Completion at Bayonne

Tide Water Associated Oil Company is expected to put into operation early in May at its refinery at Bayonne, New Jersey, a new Houdry unit embodying catalytic cracking and refining. The new plant is described as being of the combination type, including crude flashing and fractionation of virgin constituents as well as catalytic cracking of the gas oil cut of the crude charge. The unit is said to be one of the largest of the Houdry type so far built.

New Owners Reconditioning Plant at Waco, Texas

Sam H. Reaves and associates have acquired the partially dismantled crude skimming plant erected at Waco, Texas, by the Master Petroleum Company in 1931, and later operated as the Phoenix Refining Company. The new owners are rehabilitating the plant, which will have a capacity of 1000 barrels daily, using crude and distillate delivered by tank trucks.

To Dismantle 500-Barrel Plant at Olney, Texas

Southland Refining Company has suspended operations and will dismantle its 500-barrel daily capacity crude skimming plant at Olney, Texas, which has been operated since July, 1930. Charles T. Wolverton, president, stated the plant was unable to obtain an adequate volume of crude since the passing of flush production in this North Texas shallow oil belt.

Plan Cracking Plant at Memphis, Tennessee

Delta Refining Company has announced plans for a gasoline cracking plant at Memphis. Trackage has been laid to a 13-acre site, and as Mississippi River terminal will also be operated. Crude from El Dorado, Arkansas, and Mexico, to be brought by barge, will be blended with crude from Mississippi's Tinsley Dome field.

Bradford Refining Company Plans to Resume Operations

Bradford Oil Refining Company plans shortly to resume operations at its plant at Bradford, Pennsylvania, distributing products locally. The plant was shut down in 1940. John von Carlowitz is vice president and treasurer of the company.

To Increase Capacity of New York Plant 50 Percent

Allegany Refiners, Inc., has arranged for an expansion program to increase capacity from 1000 to 1500 barrels daily at its plant at Bolivar, New York. The expansion will also result in a more diversified range of oils. Hans Walchli is general manager of the company.

Wolf's Head Moves to Enlarged Office Quarters

Wolf's Head Oil Refining Company has removed its main office to an enlarged space in a new building on Seneca Street in Oil City, Pennsylvania. A. W. Scott, company vice president, stated continued growth of business necessitated the expansion program after 30 years' occupation of its old office facilities.

Mississippi Plant Shuts Down for Overstorage

E. C. Johnston's refinery at Vicksburg, Mississippi, was shut down last month, due, according to reports, to overstorage.

Building 3000-Barrel Unit at Toledo, Ohio

The Pure Oil Company has started construction on a 3000-barrel aviation unit at its refinery at Toledo, Ohio. Estimated cost of the unit is $500,000.

Seventh Edition of Facts and Figures

A 1941 or seventh edition of "Petroleum Facts and Figures" is to be published by the American Petroleum Institute within the next few weeks. The volume, in its nearly 200 pages, will include the whole range of the petroleum industry—telling statistically how it works from oil well to service station, and where its products are used. The new edition of this reference book follows previous editions in form, but contains dozens of new tables and brings up to date, with many 1940 figures, practically all tables from the 1937 and 1939 editions.

More than 240 tables are presented in the 8 sections of the 1941 volume, which has for the first time a separate section for world data. Other divisions of the book, following the major branches and operations of the petroleum industry, cover: utilization, production, refining, transportation, marketing, prices and taxes, and general. The section on transportation particularly has been expanded, and will include, in addition to many new tables tracing the movement of petroleum throughout the United States, a complete list of U. S. tank ships of more than 500 gross tons. Gross and net tonnage, year built, owner, and cargo capacity, are given.

Seven pictorial charts in color, highlighting the more important facts about each branch of the industry, are grouped in a separate section at the beginning of the volume. The first page in each section lists, with page numbers, all tables in that section.

Because of space limitations, only new and revised tables are carried back to the earliest dates. Tables which bring up to date earlier records from the fifth and sixth editions give the latest years, usually back to 1935, and refer readers to page numbers in previous editions where earlier data appear.

At least preliminary 1940 figures have been included for more than half of the tables. As far as possible, all data compiled by the various sources used up to March 15, 1941, are given; 1940 data for the remaining tables will not be available until later in 1941 and, for some tables, until 1942.

Price of the seventh edition is $1 postpaid; it may be ordered in advance of publication from the American Petroleum Institute, 50 West 50th Street, New York.

Socony-Vacuum to Build 250-Mile Gasoline Line

Socony-Vacuum Oil Company has awarded contracts for construction of a gasoline and refined products line from Topeka, Kansas, to Sioux City, Iowa, to connect with the firm's gasoline trunk line from its refinery at Augusta to Kansas City.

The line will consist of approximately 250 miles of 6-inch pipe. Contract for a 58-mile section extending northeast from Topeka has been awarded to Midwestern Engineering and Construction Company, Tulsa, for a center 91-mile section to Oklahoma Construction Company, Oklahoma City, and for a 90-mile section terminating at Sioux City, Iowa, to Jones & Brooks, Inc., Dallas.

Construction will start May 15, with completion scheduled within 60 days.

TNEC Makes No Mention of Oil in Report to Congress

Efforts to impose federal regulation on the oil industry received a severe setback when the Temporary National Economic Committee, submitting its final report to Congress, made no recommendations for oil legislation and no reference to the industry, which it had spent weeks in investigating.

Refiners know HOW TO BURN OIL EFFICIENTLY

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AIROIL—because it's the internal mixing, steam atomizing burner that's exceptionally economical to use . . .

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It operates continuously, without clogging, without need for cleaning, and consumes every atom of the heaviest fuel . . . and

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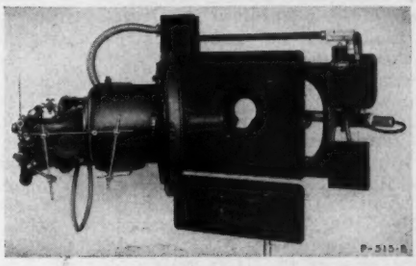
For boilers and stills and other type furnaces, AIROIL soon saves its own small cost; refiners agree: no other gives so much—for so little!

TYPE "MA" OIL BURNER

Mechanical pressure atomizing (marine type) oil burners for firing high pressure steam boilers. Capacities 10 to 500 gals. per hour. Require oil pressures of 75 to 300 lbs. per sq. in. and oil temperatures up to 300° F., depending on grade of fuel oil and furnace design. Air registers available for natural or forced draft.

TYPE "D-R" ROTARY OIL BURNERS



A complete, self-contained, motor driven, heavy duty unit designed for firing steam boilers and other furnaces, using heavy fuel oil. It embodies many exclusive features and consists basically of motor, blower and centrifugal atomizer mounted on chrome-molybdenum steel shaft, with or without integral worm-driven fuel pump; also has fuel strainer, electric oil shut-off valve, micrometer oil regulating valve, burner mounting plate and heavy swing joints. Six sizes; capacities up to 90 gal. per hr. for manual, semi-automatic and full-automatic operation.

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For details of burners and complete line of auxiliary equipment, write the NATIONAL AIROIL BURNER COMPANY, 1284 E. Sedgley Ave., Philadelphia, Pa. — "Specialists in Oil Burning for Over a Quarter Century."

Anniversary for Petroleum Division

Along with its symposium on "Analytical Methods Used in the Petroleum Industry," the Petroleum Division of the American Chemical Society celebrated its twentieth anniversary at the meeting of the society in St. Louis, April 7 to 11. The movement to form a division of the society began in 1918 and was continued largely by correspondence until the society meeting in Rochester, New York, in 1931, when 30 charter members formed the Petroleum Division, which now has grown to around 700 members.

The anniversary was stressed at the annual dinner of the division the evening of April 8 in St. Louis. It was in St. Louis in 1930 that the effort to form a petroleum division resulted in a survey being made, which a year later resulted in the organization.

The program for the first day of the symposium was:

"New Design Fully Adiabatic Fractionating Column and Precision Spaced Capillary Film Principle Wire Packing for Temperature Range from —180° to 300° C.," Walter J. Podbielniak, Podbielniak Centrifugal Super-Contractor Company, Chicago.

"Determination of the Heat of Combustion of Gasolines," W. H. Jones and C. E. Starr, Jr., Standard Oil Company of Louisiana, Baton Rouge.

"Temperature Coefficient of Density and Refractive Index for Hydrocarbons," M. R. Lipkin and S. S. Kurtz, Jr., Sun Oil Company, Marcus Hook, Pennsylvania.

"Determination of Freezing Point and Estimation of the Amount of Impurity from Time-Temperature Freezing and Melting Curves," Beveridge J. Mair, A. R. Glasgow, Jr., and Frederick D. Rossini, Bureau of Standards, Washington.

"Viscosity Measurement," M. R. Fenske and M. R. Cannon, Pennsylvania State College.

"The Ring Method for the Determination of Interfacial Tension," H. H. Zuidema and George Waters, Shell Oil Company, Inc., Wood River, Illinois.

"Analytical Procedure for Mixtures of Organic Sulphur Compounds," R. F. Robey, C. E. Morrell and B. M. Vanderbilt, Standard Oil Development Company, Elizabeth, New Jersey.

"Methods of Light Carbon Analysis," J. J. Savelli, W. D. Seyfried and B. M. Filbert, Humble Oil & Refining Company, Baytown, Texas.

"Quality Tests for Petroleum Solvent Naphthas," E. H. McArdle and E. L. Baldeschwieler, Standard Oil Development Company, Elizabeth, New Jersey.

"The Evaluation and Performance of Turbine Oils," G. H. von Fuchs, N. B. Wilson and K. R. Edlund, Shell Oil Company, Wood River, Illinois.

"The Indiana Stirring Oxidation Test for Lubricating Oils," G. G. Lamb, C. M. Loane and J. W. Gaynor, Standard Oil Company (Indiana), Whiting, Indiana.

This part of the symposium also included seven reports dealing with the separation of cobalt from iron, the colorimetric determination of iron, cobalt, lead and sulfates, the extraction of metallic constituents from oil and a new filtration cylinder by R. J. DeGray, E. P. Rittershousen and W. E. Price, Socony-Vacuum Oil Company, Paulsboro, New Jersey.

The symposium continued into the second day with these papers:

"Methods for Clarifying Oxidized or Used Mineral Oils and for the Determination of Sludge," G. O. Ebrey, Mellon Institute of Industrial Research, Pittsburgh.

"Determination of Wax in Asphaltic Products," E. C. Knowles and Harry Levin, The Texas Company, Beacon, New York.

"Consistency Test for Lubricating Greases," Charles J. Schlagel and Harry Levin, The Texas Company, Beacon, New York.

"Determination of Fatty Acids in Aluminum Soap," C. J. Boner, Battenfeld Grease & Oil Corporation, Kansas City.

General Meeting

The program of the general meeting, which followed the symposium had the following papers on refining and related subjects:

"Study of Oil Oxidation as Related to Lubrication," Paul G. Exline, Gulf Research and Development Company and W. E. Dramer and John R. Bowman, Mellon Institute of Industrial Research, Pittsburgh.

"Improved Fractional Extraction of Lubricating Oil Stocks," H. H. Cross and H. S. Smith, The Texas Company.

"Viscosity of Ethylene and of Carbon Dioxide Under Pressures," E. W. Cummings and R. S. Egly, University of Illinois, Urbana, Illinois.

"Free Energies of Formation of Gas-

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Solid: Dense, white, opaque, deliquescent solid.
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AQUA AMMONIA
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Colorless, clear solution with pungent ammonia odor. Specific gravity at 15° C. . . . 0.89; Baumé 26° . . . - 26.5°. Freezing point, below −40° F.
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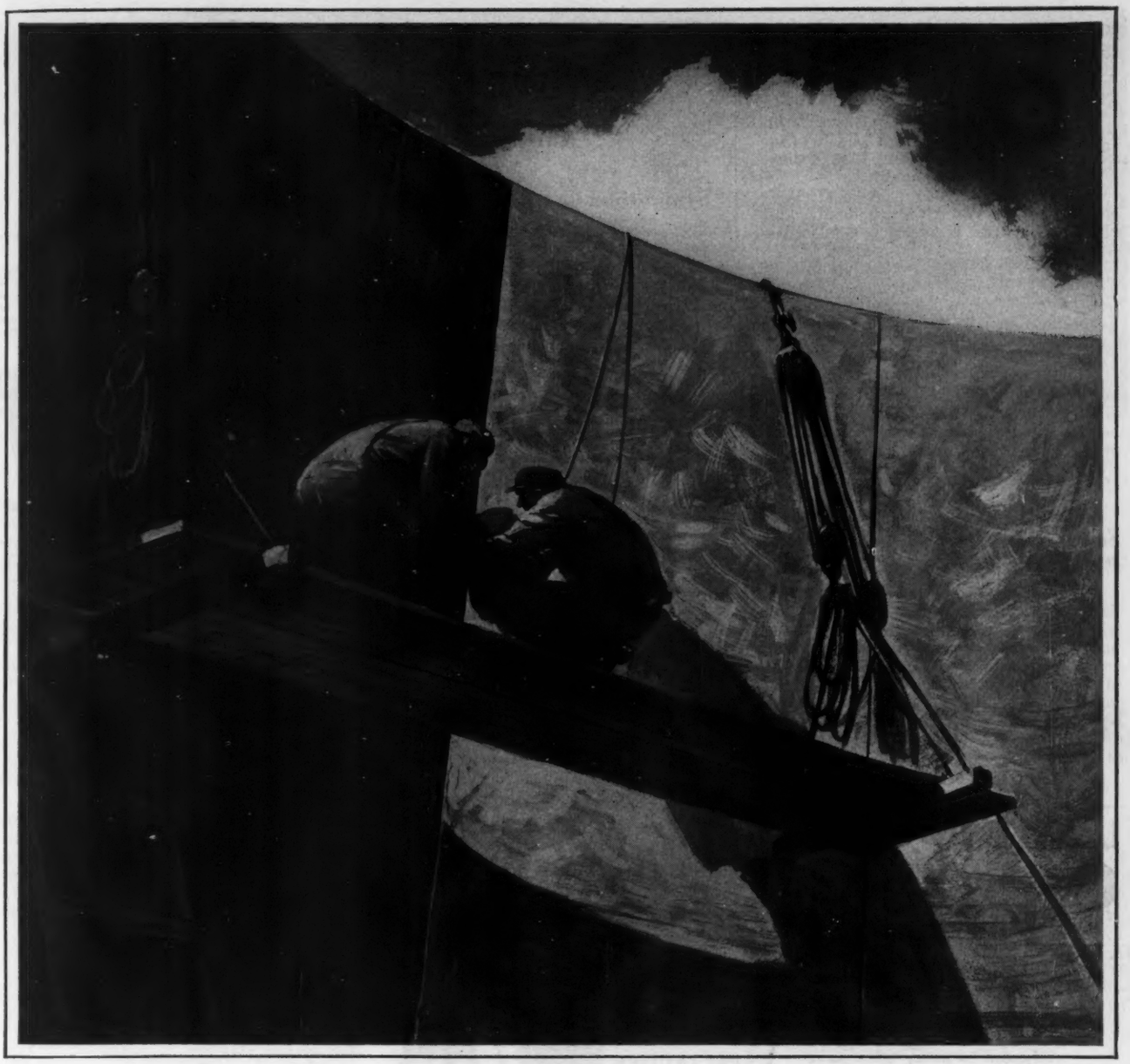
Colorless gas at normal temperatures and pressure, liquefies at −10°C. at atmospheric pressure.
LIQUID CHLORINE
Cl2
Liquefies at −34.6°C. at atmospheric pressure. Not over 1.4 lbs. moisture per ton. Total residue not over 15 grams per 100 lbs.



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eous Hydrocarbons and Related Substances at 298.1 to 1200 Degrees Kelvin," C. M. Thacker, H. O. Folkins and E. L. Miller, The Pure Oil Company, Chicago.

"Isolation of Five New Bases from California Petroleum and Their Synthesis," Leslie M. Schenck and J. R. Bailey, University of Texas, Austin.

"California Petroleum Acids," William O. Ney, W. A. Quebedeaux and H. L. Lochte, University of Texas, Austin.

"Simple Methods for Calculation of Theoretical Plates Required for Separation of Two Normal Liquids by Batch Fractionation," Arthur Rose, Pennsylvania State College, State College, Pennsylvania.

"Liquid-Vapor Equilibrium Relations in Binary Systems," W. B. Kay, Standard Oil Company (Indiana).

"Use of a Third Component to Improve the Fractional Distillation of Binary Liquid Mixtures," D. B. Keyes, University of Illinois, Urbana, Illinois.

Saybolt Retires As President of Penola

With the retirement of J. Walter Saybolt, August 1, Clarence M. Davison will become president of Penola, Inc. Saybolt is retiring also as vice president and manager of Standard Oil Company of Pennsylvania and manager of lubrication sales for Esso Marketers. Davison is manager of the wholesale lubricants department of Standard Oil Company of New Jersey.

ABSTRACTS

of Papers presented before Division of Petroleum Chemistry of the

AMERICAN CHEMICAL SOCIETY

St. Louis, Mo., April 7 to 11, 1941

Symposium on Analytical Methods Used in the Petroleum Industry

New Design Fully Adiabatic Fractionating Column and Precision Spaced Capillary Film Principle Wire Packing, for Temperature Range —180° to 300°C.

A new laboratory column is described for the operating range —180° to 300° C., with vacuum-jacketing around column, flask, reflux head and all connections, and with means for compensating residual heat leakage through jacketing. New vacuum-jacketed standard taper ground joints make four-part assembly possible, and remain vacuum tight at extreme temperatures. Flexible glass bellows serve as expansion joints.

A new precision spaced helical wire packing is described for fullest utilization capillary reflux film contacting, testing as high as 75 plates in 14 inches with *n*-heptane and methylcyclohexane test, maintaining efficiency at least up to 13 mm. diameter, as per data submitted.

The Determination of the Heat of Combustion of Gasolines.

W H. Jones and C. E. Starr, Jr., *Esso Laboratories, Standard Oil Company of Louisiana, Baton Rouge.*

The increasing importance of heat of combustion measurements in petroleum analytical work has made desirable the critical examination of the adiabatic bomb calorimeter method used for testing gasoline samples. Various errors may occur with samples of this nature, which are not encountered in less volatile liquid or solid samples.

It is shown that by rigid control of several factors, the usual accuracy of ±100 B.t.u. per pound may be improved so that ±30 B.t.u. per pound may be readily attained. In this connection results obtained on samples of pure *n*-heptane and on gasolines are described.

Temperature Coefficient of Density and Refractive Index for Hydrocarbons,

M. R. Lipkin and S. S. Kurtz, Jr., *Sun Oil Company, Marcus Hook, Pa.*

Using the equation

$$d_4^t = d_4^{20} + \alpha(t - 20) + \beta(t-20)^2$$

a single curve of α versus molecular weight and a single curve of β versus molecular weight has been found applicable to all types of hydrocarbons with very few exceptions. From these curves the temperature coefficient of density can be predicted from the molecular weight within ±0.00002 gram per cc. per °C. or better. The only definite exceptions to this relation are benzene, pentaethyl benzene, and hexapropyl benzene which show coefficients 0.00010 gram per cc. per °C. higher than the predicted values.

This relation is more general than any previously published for predicting the temperature coefficient of density.

Since Ward and Kurtz have shown that for hydrocarbons

$$\Delta n = 0.60\,\Delta d$$

an accurate method of calculating density change also provides an accurate means of calculating change in refractive index.

Determination of the Freezing Point, and Estimation of the Amount of Impurity (Solute), from Time-Temperature Freezing and Melting Curves,

Beveridge J. Mair, Augustus R. Glasgow, Jr., and Frederick D. Rossini, *National Bureau of Standards.*

Simple time-temperature freezing and melting curves are analyzed, and a procedure is outlined for determining the freezing point of a given substance and the amount of impurity in it. The procedure was applied to a number of different known solutions of hydrocarbons ranging from 0.006 to 0.115 mole fraction in concentration of solute. For the systems examined, it was found that the values for the freezing point of a given substance obtained from both freezing and melting curves were always in accord within their respective limits of uncertainty, and that the estimated amounts of impurity were in satisfactory accord with the amounts known to be present, the estimated amount being in error by not more than about 10 percent of itself on the average.

Viscosity Measurement,

M. R. Cannon and M. R. Fenske, *School of Chemistry and Physics, The Pennsylvania State College, State College, Pa.*

This paper describes a modification of the Ostwald viscometer which is particularly suitable for measuring the viscosity of opaque liquids. It is also designed for the purpose of obtaining data on shearing rate as a function of shearing stress. Such data are of fundamental importance in investigations of plastic fluids and lubricating oils at low temperatures. A lube oil with a pour point of 0° F. may be either a plastic fluid or a true Newtonian liquid in the neighborhood of 0° F. This instrument can be used to determine the type of fluid and is of value in the study of effect of pour point depressors, dewaxing, etc., on the shearing rate-shearing stress relationship.

The Ring Method for the Determination of Interfacial Tension,

H. H. Zuidema and George W. Waters, *Shell Oil Company.*

The ring method is a simple and rapid means for determining interfacial tension. However, due to various physical factors involved in the measurement, the values obtained by the ring method may be in

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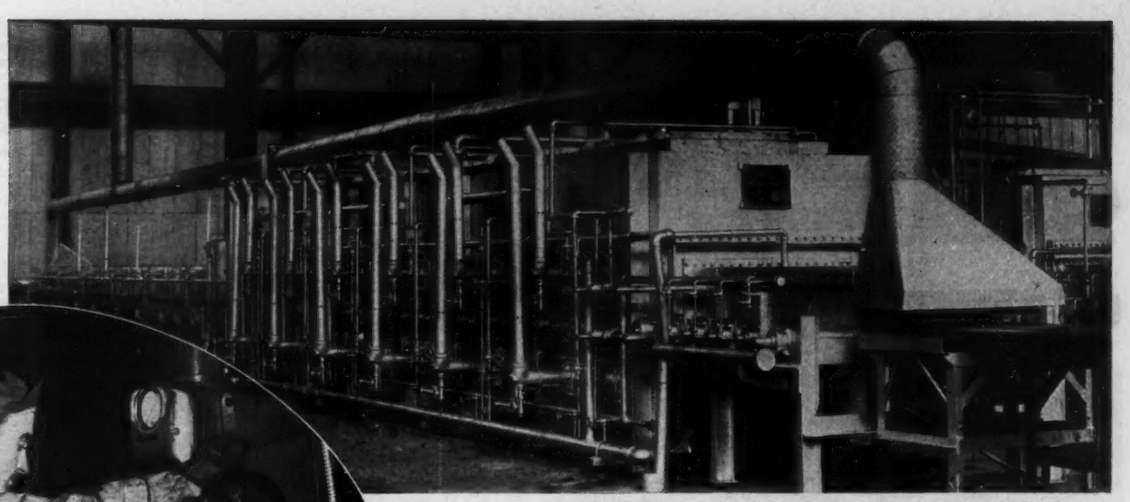

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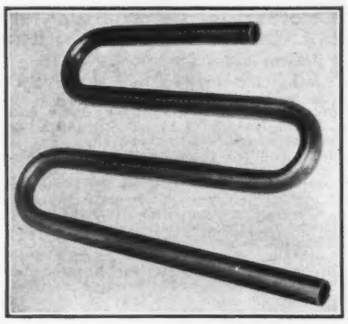

Short radius bends, such as made in this ½-inch refrigeration tube, call for working qualities that can be assured only by very accurate annealing. "OHIO QUALITY" tubes are known for uniformity of anneal.

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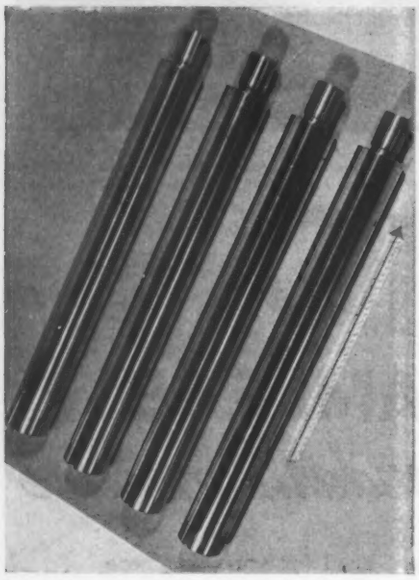

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error by as much as 30 percent. Harkins and Jordan's tables of correction factors have in the present investigation been demonstrated to follow a parabolic relationship which has been used as a basis for extrapolation to evaluate the correction factors over the extended range encountered in application of interfacial tension to hydrocarbon-water systems. The newly-established relation has been checked, using two independent instruments; values on nine different oils have been found to agree with those obtained by the capillary method.

Analytical Procedure for Mixtures of Organic Sulfur Compounds, RICHMOND T. BELL AND M. S. AGRUSS, *The Pure Oil Company.*

A method is described giving all the details for determination of sulfur as H_2S, RSH, CS_2, R_2S, R_2S_2, and elementary sulfur in a mixture of all these materials. The procedure is direct, each step following in logical sequence and has been found rapid, accurate, and practical.

Some Improvements in Methods for Determination of Unsaturates in Hydrocarbon Gases, R. F. ROBEY, C. E. MORRELL, AND B. M. VANDERBILT, *Standard Oil Development Company.*

The method for the quantitative determination of unsaturates in gaseous hydrocarbon mixtures by catalytic hydrogenation has been found to be inaccurate under certain conditions. This is due to the fact that the lower hydrocarbons do not behave as ideal gases, either when alone or in admixture with hydrogen. Corrections for this effect have been derived and presented in graphic form for ready use.

The interference of tertiary olefins in the analysis for the gaseous conjugated diolefins by absorption in maleic anhydride is obviated by including a small amount of high-boiling primary or secondary amine with the anhydride.

The reaction of piperylene with maleic anhydride is not quantitative in most cases. This has been ascribed to the very slow and incomplete reaction of one geometrical isomer.

Methods of Light Hydrocarbon Analysis. J. J. SAVELLI, W. D. SEYFRIED, AND B. M. FILBERT, *Humble Oil & Refining Company, Baytown, Texas.*

Various methods for the analysis of mixtures of light hydrocarbons from methane to *n*-pentane have been studied and compared as to their accuracy and suitability for routine operations. The methods studied have included two types of columns for fractionation of the mixtures (Podbielniak and McMillan), a method utilizing low-pressure fractional condensation (Ward), a dew pressure method for *n*-butane-isobutane mixtures, and determinations of olefins by absorption in various bromine and sulfuric acid solutions and by catalytic hydrogenation. Synthetically prepared mixtures have been used and the methods have been compared with respect to their accuracy, reproducibility, ease of manipulation, and time and material requirements. Various methods of sampling and handling light hydrocarbon mixtures have been studied and compared.

Quality Tests for Petroleum Solvent Naphthas, E. H. MCARDLE AND E. L. BALDESCHWIELER, *Standard Oil Development Company.*

Existing quality tests for petroleum solvent naphthas, including solvency, volatility, physical properties, and proximate composition, are catalogued and appraised. Data are presented graphically to show their interchangeability. Stressed is the critical importance of volatility, or average molecular weight, to the correct interpretation of any solvency test result. The standardized kauributanol method—recently criticized in several discussions of solvency—is demonstrated to serve adequately as a measure of solvent naphtha performance. It is concluded that no additional solvency tests are needed, but that lacking is the development of a rapid, precise, and accurate method for determination of evaporation rate.

The Separation of Cobalt From Iron, R. J. DEGRAY, AND E. P. RITTERSHAUSEN, *Socony-Vacuum Oil Company.*

By the addition of oxalic acid before precipitation of ferric hydroxide by ammonium hydroxide, occlusion and co-precipitation of the cobalt are prevented, and a quantitative separation is effected. If the ratio of iron to cobalt is greater than 10 to 1, the separation is not complete. The iron, however, may be partially extracted as the chloride by ether to reduce the ratio to this figure. With only two successive ether extractions, and the final use of oxalic acid, as little as 0.1% of cobalt may be determined in a steel. The oxalic acid does not interfere with the colorimetric determination of either the cobalt or the iron.

The Colorimetric Determination of Iron, E. P. RITTERSHAUSEN AND R. J. DEGRAY, *Socony-Vacuum Oil Company.*

The thiocyanate method for iron is suitable for routine work, to an accuracy of 0.05 mg., of iron, when the iron content is not over 0.4 mg. By precipitating the iron as ferric hydroxide and filtering, interfering elements are removed, and the salt concentration is controlled. Under these conditions, the color obtained by dissolving the precipitate in hydrochloric acid may be used as an indication of the iron content, of sufficient accuracy to serve as a guide for aliquoting. Both the yellow ferric chloride and red thiocyanate colors are measured photoelectrically, using a blue filter.

Colorimetric Determination of Cobalt, R. J. DEGRAY AND E. P. RITTERSHAUSEN, *Socony-Vacuum Oil Company.*

Cobalt may be determined with a limit of error of 0.06 mg. by the ammoniacal ferricyanide method, over the range of 0.5 to 4 mg. of cobalt. Larger samples can be handled by appropriate aliquot either of the final color or the original sulfate solution. The time required from the sulfate solution to the final measurement is 10 minutes or less.

Cobalt, as in paint driers, alloy steels, etc., may be separated from other cations by sulfide precipitations, etc., and from interfering anions by heating to fumes of sulfur trioxide. Except for the ferricyanide, the volumes of all the reagents need be measured only approximately.

Filtration Cylinder, E. J. DEGRAY AND E. P. RITTERSHAUSEN, *Socony-Vacuum Oil Company.*

In the colorimetric determinations of iron, lead, and sulfur, it is necessary either to filter and wash a precipitate, or to dissolve a precipitate and wash the filter, without permitting the total volume of filtrate and washings to exceed 100 ml. An apparatus is described which permits filtration by suction, directly into a volumetric flask. This standard volume filtration cylinder has been found to be more convenient than the usual suction flask even where the volumes are not important, since a clean receptacle can be introduced for each filtrate.

The Colorimetric Determination of Lead, R. J. DEGRAY AND W. E. PRICE, *Socony-Vacuum Oil Company.*

For tetraethyllead in gasoline, the hydrochloric acid solution may be evaporated to about 5 ml., ammonium acetate added, lead chromate precipitated, filtered immediately at room temperature, redissolved in a strong salt solution, and its lead content estimated from the color of the filtrate. With a photoelectric colorimeter, the method is accurate to 0.03 ml. of tetraethyllead per gallon, when a 100-ml. sample of gasoline is used. The time between evaporation and final reading is about 15 minutes.

For other lead analyses, the sulfate may be filtered, dissolved in the same ammonium acetate solution, and the colorimetric method applied. The accuracy is 0.25 mg. of lead.

The Colorimetric Determination of Sulfates, E. P. RITTERSHAUSEN AND R. J. DEGRAY, *Socony-Vacuum Oil Company.*

By the addition of a solution of barium chromate to a solution containing a soluble sulfate, barium sulfate is precipitated. By the addition of ammonium hydroxide, the unreacted barium chromate is precipitated. No long periods of digestion of the barium sulfate are required, so the precipitated sulfate and chromate can be filtered immediately. The filtrate contains the soluble chromate liberated in the reaction. The color of this filtrate may be measured photoelectrically, and sulfate thus determined.

The method is invalidated by the presence of many salts, such as would be contributed by the use of Eschka mixture or a sodium peroxide bomb. Otherwise, it is accurate to 0.1 mg. of sulfur, and requires less than 5 minutes.

Extraction of Metallic Constituents From Oil, E. P. RITTERSHAUSEN AND R. J. DEGRAY, *Socony-Vacuum Oil Company.*

This method describes the use of tetraethyllead extraction apparatus for the quantitative extraction of the metallic constituents of new and used motor oils, extreme pressure lubricants, greases, paints, and paint driers. The sample is dissolved in a suitable organic solvent which is immiscible in water. The metals are extracted into the aqueous layer by refluxing the mixture for the necessary length of time. The aqueous layer is

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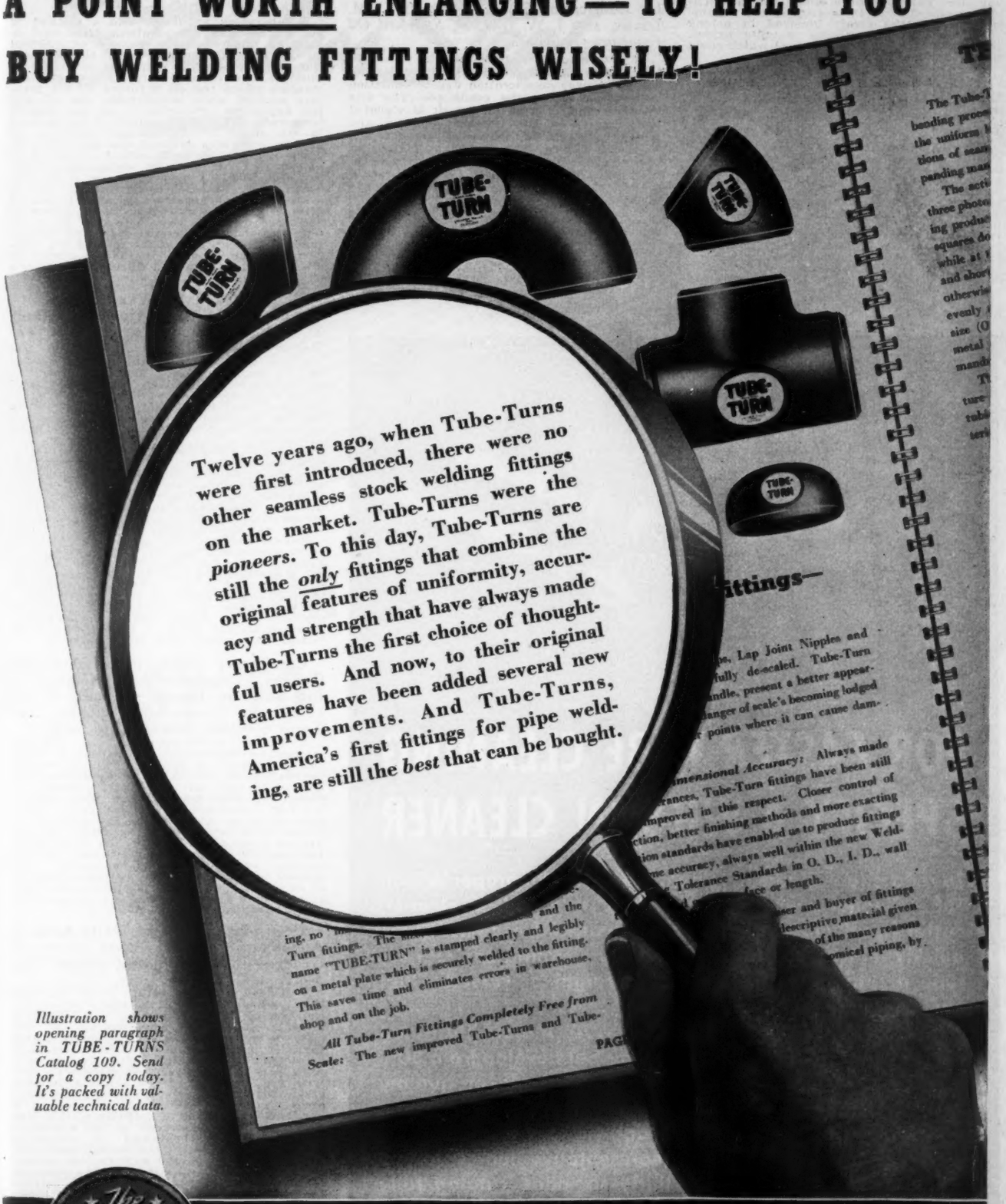
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drawn off and analyzed for the metals it contains. This procedure eliminates the difficulties encountered in destroying the organic matter, and the errors involved in ashing compounds having volatile metallic oxides. No metals have been encountered which could not be handled by this method.

The Evaluation and Performance of Turbine Oils, G. H. VON FUCHS, N. B. WILSON, AND K. R. EDLUND, *Shell Oil Company.*

Progress in the design and construction of steam turbines has introduced new problems in lubrication and aggravated old ones. The importance of predicting the behavior in service of turbine oils has led to the delevopment of suitable accelerated laboratory tests. Two essential requisites of a good turbine lubricant are the ability to protect steel surfaces against rusting and high stability toward oxidation. Application of these tests has revealed striking differences among the leading turbine oils. A discussion is presented of the chemical factors which influence the performance of oils in relation to the various methods employed by turbine operators to maintain an oil in serviceable condition.

The Indiana Stirring Oxidation Test for Lubricating Oils, G. G. LAMB, C. M. LOANE, AND J. W. GAYNOR, *Standard Oil Company (Indiana).*

A new laboratory technique is presented for measuring the stability of lubricating oils as regards deterioration due to oxidation such as occurs in the crankcase. The test involves rapid stirring of the oil at elevated temperatures in the presence of iron and copper catalysts in controlled amount and surface condition. The important feature of the test is that the volatile products of oxidation are retained in the oil much longer than in blowing tests and they therefore have greater influence on the oil deterioration. The effect of changing the variables in the test conditions is illustrated. The test, with minor changes, is applicable to the study of bearing corrosion and to the study of the oxidation stability of a wide variety of oils.

Methods for Clarifying Oxidized or Used Mineral Oils and for the Determination of Sludge, G. O. EBREY, *Mellon Institute of Industrial Research, Pittsburgh, Pa.*

A laboratory apparatus and a method of use are described for obtaining from used or oxidized mineral oils a sample of clarified oil free of sludge undissloved at the clarification temperature. The clarifying or filter medium is two Seitz S-3 type asbestos disks through which the oil is forced by gas pressure applied while maintaining the oil and the apparatus containing it at the desired temperature. The applications of the method in the study of the changes occurring in used or otherwise oxidized oils are indicated.

The construction and method of use of an apparatus for mineral oil sludge determination are described. The apparatus is of such design that an open-bottom metal cup is drawn down and sealed against a supported Seitz S-3 type asbestos disk which serves as the filter medium. This Seitz disk is in effect a preformed asbestos mat. The advantages and limitations of the method are mentioned. Modified uses of the apparatus in other ways than suction filtration of diluted oils are suggested.

Determination of Wax in Asphaltic Products. A Propane-Hexone Method, E. C. KNOWLES AND HARRY LEVIN, *The Texas Company, Beacon, New York.*

A new method is described for determining wax in asphalt. It comprises separating the asphaltene-resin fraction from the oil-wax fraction by hot liquid propane under pressure and determining the wax in the oil-wax fraction by crystallization at low temperatures from solution in methyl isobutyl ketone (hexone).

The mild condition of the propane treatment effects a clean removal of the asphaltene-resin fraction, which interferes generally with crystallization methods for wax. Thus, it avoids the detrimental effects of more drastic pretreatments, such as digestion with strong sulfuric acid or destructive distillation, which may destroy some of the wax.

Hexone possesses the necessary properties of an outstanding reagent for wax determinations—namely, high oil solvent power, low wax solvent power, and good filtration rates.

Data are given on asphaltic samples containing known additions of wax. The new method shows the wax content of many asphalts to be higher than has long been assumed on the basis of the less accurate, though extensively used, Holde method.

Consistency Test for Lubricating Greases. Counterbalance Modification for Soft or Liquid Greases, HARRY LEVIN AND CHARLES J. SCHLAGEL, *The Texas Company, Beacon, New York.*

A simple modification of the A.S.T.M. method for determining consistency of lubricating greases is described which extends the utility of the A.S.T.M. apparatus and method to very soft and liquid greases. Although it does not interfere with regular A.S.T.M. penetrations the apparatus modification is one that can be installed or removed in a few minutes by simply disconnecting a thread. In essence, the modification consists in counterbalancing the moving weights of the A.S.T.M. apparatus (150 grams) to any desired lesser weight. The use of such lesser weights brings the penetration of very soft greases within the scale of the standard apparatus.

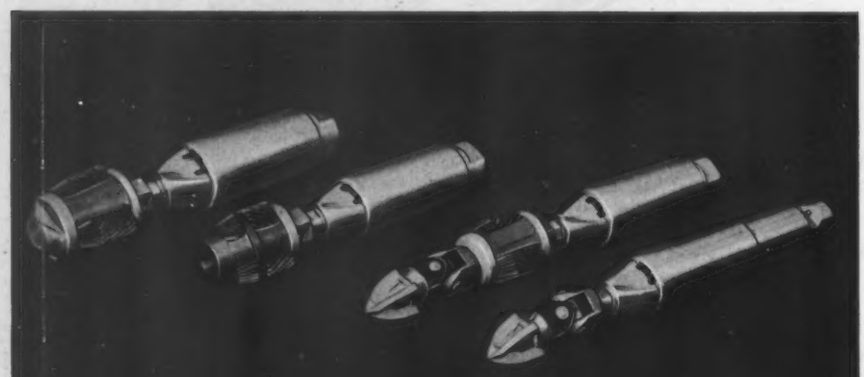
Determination of Free Fatty Acids in Aluminum Soap, C. J. BONER, *Battenfeld, Grease & Oil Corporation, Kansas City, Mo.*

A review of the literature shows that the only methods in use for the above determination depend upon extraction with different solvents. A careful investigation of the methods and solvents advocated shows a wide variation in the percentage of free fatty acids extracted from aluminum soaps. Experimental work with other solvents shows similar differences. Since one of the solvents, namely, ethyl alcohol containing water, normally gives higher extractions than the others, it appeared there was a possibility that the water promoted hydrolysis of the aluminum soaps. This was confirmed by extracting parallel samples with dry solvent and with the same solvent diluted with various proportions of water. Results indicate the need for further work to provide a satisfactory method for determination of free fatty acids in aluminum soaps.

Chemistry in Exploration for Petroleum, LEO HORVITZ, *Subterrex, Houston, Texas.*

This paper describes the application of chemical methods to exploration for petroleum. The techniques developed are referred to as geochemical prospecting methods.

Two separate techniques are described. The first involves the analysis of samples of soil or soil air, collected near the surface of the earth, for the purpose of outlining the areal extent of a buried oil or gas accumulation. The second involves the analysis of cuttings and cores, collected during the drilling of a



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Study of Oil Oxidation as Related to Lubrication. I. Apparatus and Technique, PAUL G. EXLINE, *Gulf Research & Development Company,* AND W. E. KRAMER AND JOHN R. BOWMAN, *Melton Institute, Pittsburgh, Pa.*

A machine is described for the observation of the lubrication characteristics of oils during the course of their oxidation. It comprises a full cylindrical bearing 1 inch long and 1 inch in diameter which is run continuously at constant speed and constant temperature while varying load. The loading cycle begins at zero load and increases almost linearly with time to incipient seizure; at this point it is reduced back to zero very rapidly, and the cycle begins again automatically. Many loading cycles are recorded in the course of a test, and load and torque are continuously recorded. The oil system is built in such a manner that it may be blanketed with any desired atmosphere. Air and nitrogen are generally used alternately.

Data from a few typical runs are given. Evidence is presented indicating that oxidation increases the incipient seizure load—i.e., the load-carrying capacity of the oil. The effect is a temporary one; the seizure load decreases to near its initial value shortly after the air is displaced with nitrogen.

In the case of an oil containing an antioxidant, no such phenomena were observed.

A table is presented showing relative load-carrying capacities of several commercial oils.

Improved Fractional Extraction of Lubricating Oil Stocks, H. H. GROSS AND H. S. SMITH, *The Texas Company, Beacon, New York.*

The fractionating mechanism of the fractional extractor for lubricating oil stocks originally described by Fenske and co-workers is reviewed, with particular regard to the fractionation of the more aromatic portions of the charge. The desirability of maintaining a low solubility of the refluxed extract in the solution at the top of the column is illustrated by data showing the improved fractionation thereby obtained.

Descriptions are given of the methods employed for refluxing highly viscous extracts and for adjusting the water content of the solvent in order to regulate extract solubility. Possibilities for increasing the flexibility of the apparatus are outlined.

Viscosity of Ethylene and of Carbon Dioxide Under Pressure, E. W. COMMINGS AND R. S. EGLY, *University of Illinois.*

The viscosity of ethylene vapor was measured at 40° C. and at pressures from 50 to 2000 pounds per square inch. The vapor was forced through a glass capillary by the weight of a pellet of mercury and the time of fall of the pellet determined. The viscometer was calibrated independent of the results on any other gas but the calibration was checked by measurements on carbon dioxide vapor. The values reported are averages of a number of measurements made with several sizes of pellet. The maximum probable error is 2 percent below 1300 pounds per square inch and 4 percent above this pressure.

Free Energies of Formation of Gaseous Hydrocarbons and Related Substances at 298.1 to 1200° K., C. M. THACKER, H. O. FOLKINS, AND E. L. MILLER, *The Pure Oil Company, Chicago.*

Standard free energies of formation have been calculated for 77 hydrocarbons and 8 inorganic compounds in the gaseous state at 100° intervals from 298.1 to 1200° K.

The tables include values for the normal paraffins, methane to normal decane, the 1-olefins, ethylene to 1-decene; various branched-chained saturates and unsaturates of four to eight carbon atoms; and the inorganic compounds, carbon monoxide, carbon dioxide, water, ammonia, carbon disulfide, hydrogen sulfide, sulfur dioxide, and sulfur trioxide.

Distinction is made between the more accurate values for straight-chain hydrocarbons and those for their branched-chain isomers.

Isolation of Five New Bases from California Petroleum and Their Synthesis, LESLIE M. SCHENCK AND J. R. BAILEY, *University of Texas.*

The new bases presented in this paper include 2,3,4-trimethyl-8-1-propylquinoline, 2,3-dimethyl-4,8-diethylquinoline, 2,3-dimethyl-4-ethyl-8-n-propylquioline, 2,3-dimethyl benzo (h) quinoline, and 2,4-dimethylbenzo (h) quinoline.

This contribution increases the quinoline type bases isolated in the Texas Laboratory to twenty-one. The dimethyl-benzoquinolines are the first representatives of this family of nitrogen compounds to be obtained from a natural source.

The laboratory technique employed in the isolation of the new compounds includes exhaustive fractional distillation, cumulative extraction, sulfiting and degassing, countercurrent extraction, and final purification through the crystallizing properties of their organic and inorganic acid salts. In all cases the structures assigned the bases have been confirmed by synthesis.

California Petroleum Acids, WM. O. NEY, W. A. QUEBEDEAUX, AND H. L. LOCHTE, *The University of Texas.*

In continuation of work on petroleum acids from California straight-run gasoline 8 additional aliphatic and 1-naphthentic acid have been isolated and identified from the methyl esters through careful fractionation.

2-Methyl, 3-methylpentanoic, *n*-hexanoic, 2-methyl, 3-methyl, 4-methyl, 5-methylhexanoic, and *n*-heptanoic acids, six of these for the first time from petroleum, were identified, as was cyclopentane carboxylic acid which had been found previously in European petroleum acids.

Simple Methods for Calculation of Theoretical Plates Required for Separation of Two Normal Liquids by Batch Fractionation, ARTHUR ROSE, *The Pennsylvania State College.*

For mixtures of similar normal liquids with normal vapor liquid equilibrium relations, and in cases where the usual simplifying assumptions of distillation and negligible holdup are justified, the equations

$$n = \frac{2.85}{\log_{10}\alpha} = R \quad \text{and} \quad n = \frac{T_B + T_A}{3(T_B - T_A)} = R$$

are suggested for estimating approximately the equivalent number of theoretical plates (n) and the reflux ratio (R) suitable for a standard separation in which the first 40% distilled has an average purity of 95 mole %. The derivation of the equations is described, the limitations of such approximation formulas are emphasized, and they are compared with a correlation of more accurate Rayleigh type calculations which show that the number of plates required may be chosen from any value within a limited range, provided the accompanying reflux is properly fixed. The limits of the range of plates required and the methods of choosing the proper reflux are indicated. The temperatures in the above equation are °K and T_B is the higher temperature.

Liquid-Vapor Equilibrium Relations in Binary Systems. The *n*-Butane–*n*-Heptane System, W. B. KAY, *Standard Oil Company (Indiana), Whiting, Indiana.*

The P-V-T-x relations at the liquid- and vapor-phase boundaries in the *n*-butane-*n*-heptane system were worked out from measurements on a series of mixtures varying in composition from pure *n*-butane to pure *n*-heptane. T-x diagrams of the coexisting liquid and vapor at constant pressure were constructed, from which data were obtained for calculating the phase equilibrium constants. Information on the effect of the physical properties of the mixture on the phase equilibrium constants is given by a comparison of the constants for *n*-butane dissolved in ethane and in *n*-heptane and the same for *n*-heptane dissolved in ethane and in *n*-butane.

Use of a Third Component to Improve the Fractional Distillation of Binary Liquid Mixtures, D. B. KEYES, *University of Illinois, Urbana, Illinois.*

The use of a third component to improve the fractional distillation of binary liquid mixtures, such as two hydrocarbons with approximately the same boiling point, has attracted considerable interest recently. The basis for the selection of a satisfactory third liquid and the proper design of the process for commercial operation are briefly reviewed. The relative importance of the various factors is shown, with the hope that a clearer understanding may be had of the basis of the operation and more applications can be made, especially in the petroleum industry.

Hydrogenation of High-Volatile Bituminous Coals. Summary of Assays of Bituminous, Subbituminous Coals and Lignites, L. L. HIRST, R. L. BOYER, A. EISNER, I. I. PINKEL, AND H. H. STORCH, *U. S. Bureau of Mines.*

The results are given of liquid-phase hydrogenation assays in the Bureau of Mines experimental plant of four additional bituminous coals—namely, high-volatile A coals from the Upper Freeport (W. Va.) and the Black Creek (Ala.) beds, high-volatile B coal from the Lower Sunnyside (Utah) bed, and high-volatile C coal from the Indiana No. 4 bed. A summary is presented of the results with eight bituminous, three subbituminous coals, and two lignites. The yield of tar acids increases with decreasing rank from about 6 percent (of the moisture- and ash-free coal) for the high volatile bituminous coals of highest rank to about 16 percent for subbituminous coals of lowest rank and for lignites. About one-half of the tar acids boil below 235° C. at atmospheric pressure. Of these low-boiling tar acids about 50 percent is xylenols, 30 percent cresols, and 20 percent phenol. The neutral oil boiling above 188° C. contains only very small amounts of paraffins and consists mainly of aromatics and naphthenes. About 7 percent of cyclic olefins is present. The neutral oil boiling in the range 20° to 188° C. contains about 33 percent of saturated paraffins, 8 percent olefins, 38 percent naphthenes, and 21 percent aromatics. The yield of neutral oil is about 60 percent (of the moisture- and ash-free coals) for bituminous, 50 for subbituminous coals, and 38 for lignites.

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Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical And Chemical Data

Low-Temperature Gaseous Heat Capacities of Certain C_3 Hydrocarbons, G. B. KISTIAKOWSLY, J. R. LACHER AND W. W. RANSOM, *J. Chem. Phys.* **8** (1940) pp. 970-7.

The thermal conductivities of allene, propylene, propane, methyl acetylene and cyclopropane were measured at low pressure over the temperature range 150 to 340° K. The heat capacities as derived from these measurements are compared with those of others. Data are presented in support of the bracketing method for deriving heat capacities from heat conductances. Heats of certain hydrogenation reactions, when calculated to 0° K. and to the nonvibrating state, are found to show the same regularities as the experimental values determined at 335° K.

Some Observations on the Thermodynamics of Hydrocarbons and Related Compounds, J. G. ASTON, *Chem. Rev.* **27** (1940) pp. 59-73.

In calculating thermodynamic functions of hydrocarbons and similar compounds from spectroscopic and molecular data account must be taken of potentials hindering free rotation. Values obtained from the third law of thermodynamics are correct. If a third-law value is available for the entropy of a gaseous compound at room temperature (or at the normal boiling point) and if the spectroscopic and molecular data are fairly complete, the potentials hindering internal rotation can be obtained, the entropy calculation will agree statistically with the third law value. These potentials can then be used with the molecular and spectroscopic data to obtain the heat capacity, heat content and free energy of the compound over the temperature range considered.

Some Physical Data on Alkyl Cyclohexanes, A. W. SCHMIDT AND A. GROSSER, *Ber.* **73B** (1940) pp. 930-3.

The alkyl cyclohexanes were obtained by catalytic reduction of alkyl benzenes. An Adams platinum oxide catalyst was used, and although the reduction was slow, even though precautions were taken to use only very pure starting materials, the yields of the final products obtained were more than 90% of the theoretical yield. Melting points, boiling points, and refractive indices of the compounds as functions of the number of carbon atoms fall on smooth curves. The Ubbelohde-Walther viscosity-temperature relationship is linear. The data from the literature on the same and on several other alkyl cyclohexanes usually fall on the same curves and lines, although in some instances considerable deviations were noted. Data are given for butyl-, heptyl-, dodecyl-, tetradecyl- and hexadecyl-cyclohexanes.

Two-Phase Equilibrium in Binary and Ternary Systems. II. The System Methane-Ethylene, M. GUTER, D. M. NEWITT AND M. RUHEMANN, *Proc. Roy. Soc.* (London) **A176** (1940) pp. 140-6.

The liquid-vapor equilibrium of the system CH_4—C_2H_4 was determined at 0°, —42°, —78°, —88°, and —104° over a wide range of pressures. The data are presented as a pressure-composition - temperature diagram and by pressure-composition curves.

Viscosity of Liquids, E. N. DA C. ANDRADE, *Proc. Phys. Soc.* (London) **52** (1940) pp. 748-58.

The melting point viscosities of 5 classes of liquids are considered on the basis of Andrade's theory of viscosity in which $n_M = \beta \frac{(AT_M)^{1/2}}{V^{2/3}}$, in which n_M is the coefficient of viscosity at the melting point $T°_M K$; A is the molecular weight; and V, the molal volume at the melting point. For the monatomic liquids, A, K, Cs, Na, Sn, Hg, Pb, Cu the values of $\beta \times 10^4$ range from 4.51 for argon to 6.39 for sodium with an average value of 5.56. With the fused alkali, halides, i.e., salts of cubic structure, the average $\beta = 6.03 \times 10^{-4}$, within experimental error of the value for the monatomic liquids. For the molecules with central symmetry such as CH_4, CCl_4, $SiCl_4$ the value of $\beta \times 10^4$ are 20.1, 20.5, 18.5. For Cl_2, Br_2, and I_2, $\beta \times 10^4 = 10.9$, 9.0, 10.5. Structural effect in the paraffin series is illustrated by the data for $CH_4C_8H_{18}$, $C_{10}H_{22}$, $C_{11}H_{24}$ for which the values of $\beta \times 10^4$ are, respectively, 20.1, 36.2, 41.9, 51.3. The variation for the unsymmetrical molecules is to be expected because they exchange momentum in a way not taken into account in the theory, namely, by getting into one another's way. The effect of an electrical field on viscosity is discussed. This effect is found only for liquids that give ions, and the problem remains largely unsolved.

Viscosity Characteristics of Lubricating Oils as Related to Their Chemical Structure, B. YAMAGUTI, *Rept. Aeronaut. Res. Inst.,* Tokyo Imp. Univ. **15** (1940) pp. 111-36 (English Abs.).

No well defined relationship exists between the chemical structure and viscosity index of hydrocarbons of high molecular weight, but the viscosity-temperature coefficient for liquids at the same viscosity is shown theoretically and experimentally to be a characteristic function of the chemical structure. Calculations of the viscosity-temperature coefficient at a viscosity of 100 centistokes of several synthetic hydrocarbons of high molecular weight by means of Walther's equation indicates that an increase in the entangling degree of a molecule results in a decrease in the viscosity-temperature coefficient or in the "structure viscosity index." Either viscosity index or "structure viscosity index" can be used in the grading

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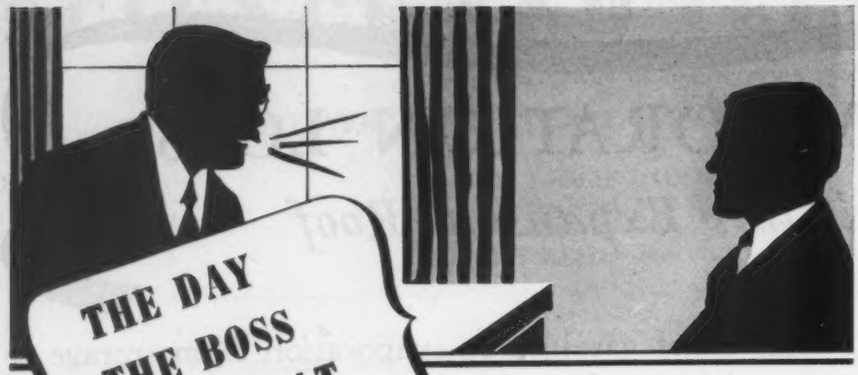

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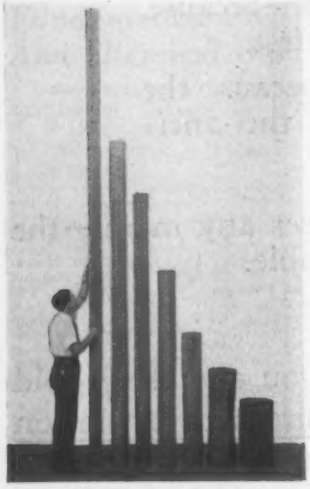

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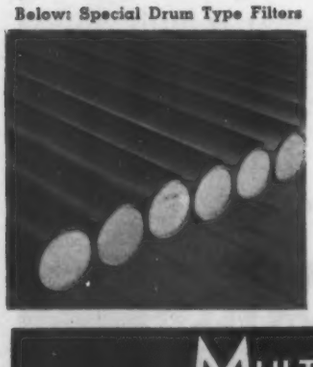

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of the viscosity characteristics of oils. The "structure viscosity index" is 100 times the sum of the viscosity-temperature coefficient and 5. The smaller the "structure viscosity index" the better are the viscosity characteristics. The "structure viscosity index" can be used to show the enhancing effect of an addition agent such as paratone.

Two-Phase Equilibrium in Binary and Ternary Systems. III. The System Methane - Ethane - Ethylene, M. GUTER, D. M. NEWITT AND M. RUHEMANN, *Proc. Roy. Soc.* (London) **A176** (1940) pp. 146-52.

The liquid-vapor equilibrium of the ternary system CH_4—C_2H_6—C_2H_4 was determined at —104°, —78° and 0° C. Data for the binary systems CH_4—C_2H_6 and CH_4—C_2H_4 and for the ternary system CH_4—C_2H_6—C_2H_4 are presented on a composite pressure-composition diagram.

Chemical Compositions And Reactions

Isomerizing Action of Cyclizing Catalysts, J. TURKEVICH AND H. H. YOUNG, JR., *Jour. Amer. Chem. Soc.* **65** (1941) pp. 519-20.

The process of aromatization of heptane and other saturated hydrocarbons has been reported by several investigators. Most of the work has included the use of normal hydrocarbons and the oxides of chromium, vanadium and molybdenum as catalysts. The question arises as to whether these catalysts have any isomerizing properties, i.e., whether there is any isomerization of the hydrocarbon charged but is not dehydrogenated to olefins and aromatics, or, on the other hand whether there is aromatization of branched chain hydrocarbons that do not have at least six carbon atoms in the chain. It was found that unsupported chromium oxide, chromium oxide on alumina, and alumina on chromium oxide, and vanadium oxide on alumina, do not aromatize 2,2,4-trimethylpentane at 475° C. Molybdenum oxide on alumina at 475° C. gives small but definite amounts of aromatics from 2,2,4-trimethylpentane, indicating isomerizing properties of this cyclizing catalyst. Olefin production from n-heptane and 2,2,4-trimethylpentane on aromatizing isomerizing catalyst is the same, while on aromatizing non-isomerizing catalyst, 2,2,4-trimethylpentane yields more olefins than n-heptane.

The Isolation and Properties of 1,1-Dineopentylethylene, a Component of Triisobutylene, P. D. BARTLETT, G. L. FRASER AND R. B. WOODWARD, *Jour. Amer. Chem. Soc.* **65** (1941) pp. 495-8.

Previous work has indicated that triisobutylene is a mixture of three isomers, 1,1-dineopentylethylene, 1-methyl-1-neopentyl-2-t-butylethylene, and 1,1-dimethyl-2,2-di-t-butylethylene. It was found that the prolonged action of hot, concentrated alkaline permanganate upon triisobutylene leaves half of the hydrocarbon unchanged. This inert component of triisobutylene has been shown to be 1,1-cineopentylethylene. It has been catalytically hydrogenated, converted to an epoxide and, through this and an isomeric aldehyde, to dineopentylacetic acid. The attacked component of triisobutylene is converted into carbon dioxide, trimethylacetic and dimethylmalonic acids under the same treatment.

Recent Progress in Chlorination, 1937-1940, E. T. MCBEE AND H. B. HASS, *Ind. & Eng. Chem.* **33** (1941) pp. 137-42.

The literature of the past few years discloses much active interest in the chlorination of organic compounds. The authors review and discuss some of the recent discoveries in this field, including the substitutive chlorination of olefins, peroxide-catalyzed chlorinations with sulfuryl chloride, chlorinations in intimate contact with a liquid mass of metallic chlorides, preparation of polychloropropanes, chlorination of natural gas, chlorination of aromatic compounds, chlorinolysis of paraffin hydrocarbons, high-pressure chlorination of paraffin hydrocarbons, hexachloroethane as a chlorinating agent, the chlorination of esters, the chlorination of rubber, and the use of a capillary for introducing chlorine into material to be chlorinated.

Chlorinolysis of Chloropentanes, E. T. MCBEE, H. B. HASS AND E. PIERSON, *Ind. & Eng. Chem.* **33** (1941) pp. 181-5.

A high-temperature high-pressure chlorination of chloropentanes was studied and found to result in the formation of hexachloroethane, carbon tetrachloride, and hexachlorobutadiene. The term "chlorinolysis" is proposed as being descriptive of reactions of this type. At 400° C. and a pressure of 1000 pounds per square inch the conversion to carbon tetra-

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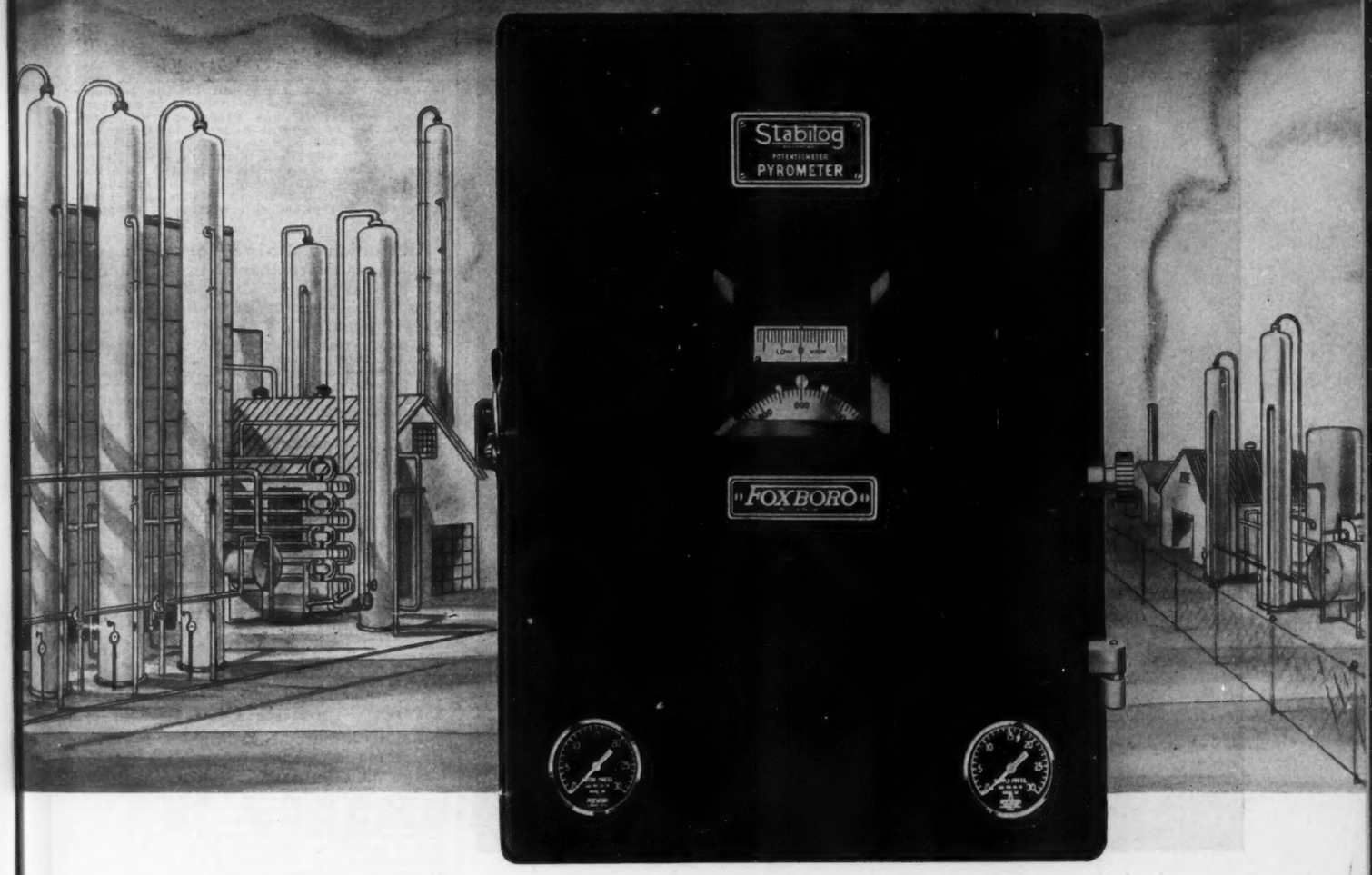

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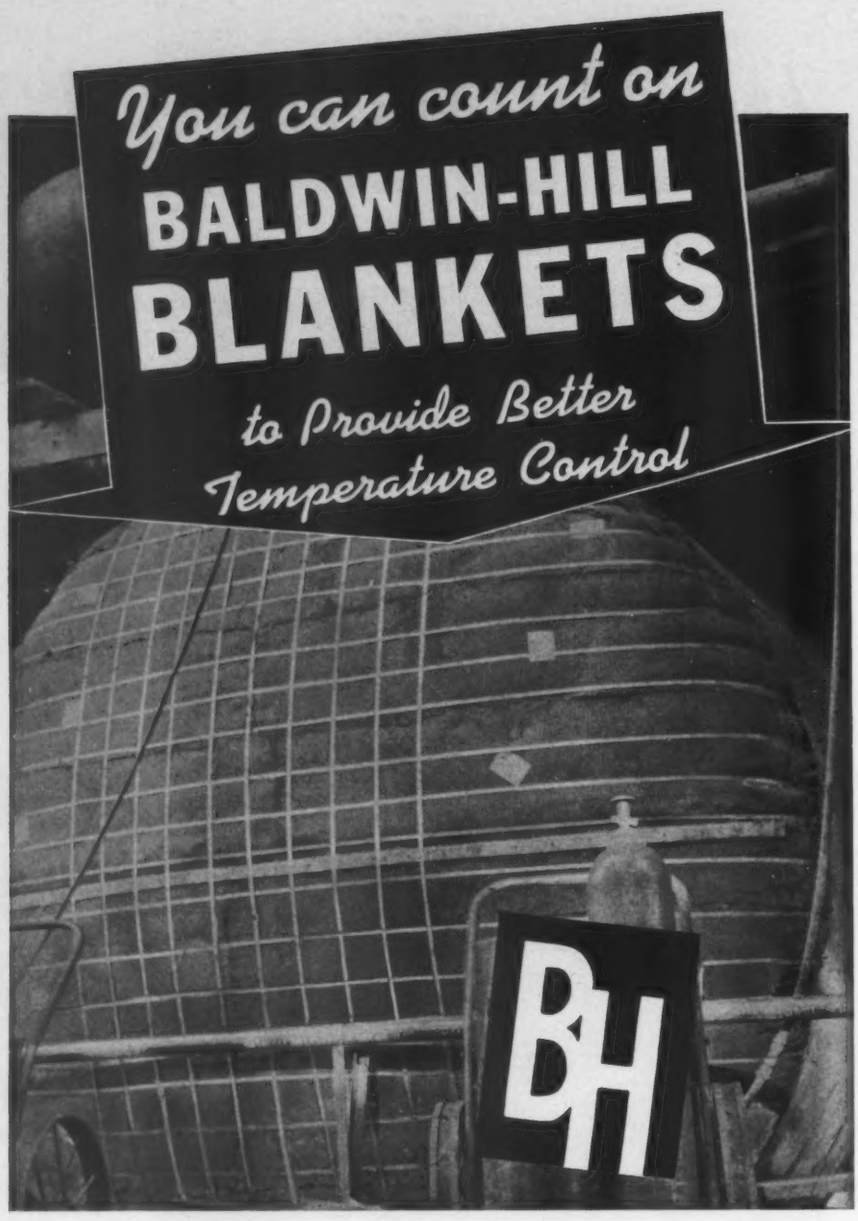

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chloride and hexachloroethane was approximately 90 percent, and the potential yield of these products approaches the theoretical value. Explosions and carbonization were prevented by the use of excess chlorine. The apparatus used is described in some detail including a suitable arrangement for the pumping of liquid chlorine.

High-Pressure Chlorination of Paraffins, E. T. McBee, H. B. Hass and J. A. Pianfetti, *Ind. & Eng. Chem.* **33** (1941) pp. 185-8.

It was found that the liquid-phase chlorination of paraffin hydrocarbons yields a higher percentage of primary substitution products than are obtainable in the vapor phase at the same temperature. This led to an investigation of the high-pressure chlorination at elevated temperatures. It was found, for example, in the course of the investigation, that in the chlorination of propane at 300° C. there is an increase in the yield of the primary substitution product with increase in pressure. The investigation was extended to include chlorination of several hydrocarbons at pressures up to 4000 pounds per square inch. The apparatus is described in some detail. Representative data are presented for the chlorination of propane, n-pentane and n-heptane. A comparison of the liquid phase and high-pressure vapor-phase chlorination of propanes is presented.

Utilization of Polychloropropanes and Hexachloroethane, E. T. McBee, H. B. Hass, T. H. Chao, Z. D. Welch and L. E. Thomas, *Ind. & Eng. Chem.* **33** (1941) pp. 176-81.

A new term "chlorinolysis" is proposed to describe the process of chlorinating an organic compound under conditions that rupture the carbon-carbon bonds and yield chlorocarbons with a smaller number of carbon atoms than the starting material. This process is conducted by mixing dichloropropanes with the quantity of chlorine necessary to yield carbon tetrachloride and hexachloroethane exclusively and submitting the mixture to thermal reaction at superatmospheric pressure. Work was done on the stability of the several dichloropropanes. 2,2-Dichloropropane is not as stable as 1,1-dichloropropane or 1,2-dichloropropane. Work was done on the perchlorination of aliphatic hydrocarbons other than methane and ethane. Octachloropropane was prepared. The pyrolysis of this substance was studied, as well as that of hexachloroethane. Octachloropropane yields carbon tetrachloride and tetrachloroethylene.

Manufacture: Processes and Plant

Semicommercial Columns for Close Fractionation, L. B. Bragg, *Ind. & Eng. Chem.* **33** (1941) pp. 279-82.

Tests are reported on a triangular pyramid-type packing as developed by Stedman. Thirty-six inches of packing were used in each of three columns, approximately 2 inches, 3 inches and 6 inches in diameter. The packing and its assembly into the inserts for the columns, as well as the flow of vapor and liquid over and through the packing, are described in some detail. The columns were operated under total reflux and column hold-up was determined. The heights equivalent to a theoretical plate were determined for different reflux ratios for each column, and the results are presented in graphical form. The conclusion is drawn that at comparable vapor velocities better efficiencies are possible with Stedman packing than with other types of packing. The efficiencies are accomplished at unusually low liquid hold-up and with pressure drops that compare favorably with those of other types of packing. Throughput is satisfactory and comparable to that of other packings, as is indicated by the possible superficial vapor velocities of 2.6 and 2.8 feet per second for the three sizes of packing. In continuous operation the packing can be run at some point between the flood point and the point of complete flooding. In batch distillation, however, the higher hold-up in this region is a handicap that would in general prevent the use of distillation rates greater than those at the flood point. By the use of this packing it will be possible to build semi-commercial columns having as many as 100 theoretical plates in apparatus that can be housed in a laboratory of average height.

Nomograph for Equivalent Diameters of Annuli, D. S. Davis, *Ind. & Eng. Chem.* **33** (1941) p. 248.

In connection with the design of double-pipe coolers, calculation of the film coefficient of the fluid flowing in the annular space is made by means of the Dittus-Boelter equation. In this equation D is the inner diameter of the pipe in feet. In the case of an annulus D should be the equivalent diam-

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eter defined as 4 times the hydraulic radius, which is the area of the annulus divided by the perimeter. A nomograph is presented that facilitates the ready computation of the equivalent diameters of the annuli.

Failure of Low-Carbon Steel Still Tubes, R. H. THIELEMANN, *Met. & Alloys* **12** (1940) pp. 298-300.

Intercrystalline fractures occasionally occur when low-carbon steels are creep-loaded, but only after long periods at low stresses and high temperature. At 538° C. a killed 0.15% carbon steel showed intercrystalline failures at stresses of less than 10,000 pounds per square inch. Rimmed steel of similar composition, although weaker, fractured in the normal ductile transcrystalline manner at all test stresses greater than 6,000 pounds per square inch.

Flow of Muds, Sludges, and Suspensions in Circular Pipe, D. H. CALDWELL AND H. E. BABBITT, *Ind. & Eng. Chem.* **33** (1941) pp. 249-56.

A theoretical anlysis of the flow of sludges in circular pipe is presented. It was found that two distinct types of flow occurred, depending upon the velocity of the fluid. These two types are termed "plastic flow" and "turbulent flow." The velocity at which plastic flow changes to turbulent flow is called the "critical velocity." Equations are developed and verified experimentally for determining friction losses for plastic flow and for turbulent flow in circular pipe. An equation for determining the critical velocity is also given, together with experimental verification for it. Methods of determining the constants in the plastic flow and critical velocity equations are described.

Hydrogenation of High-Temperature Tar from By-Product Coke Ovens, H. H. STORCH, L. L. HIRST AND C. H. FISHER, H. K. WORK AND F. W. WAGNER, *Ind. & Eng. Chem.* **33** (1941) pp. 264-74.

Considerable experimental work has been done on the hydrogenation of low-temperature tars, but little has been published on the hydrogenation of high-temperature tars. Aromatic solvents can be produced from high-temperature coke-oven tar by hydrogenation. Two stages of hydrogenation are essential: first, the liquid phase, in which the tar is mixed with a small amount of catalyst and pumped into the converter along with hydrogen under pressure, and the vapor phase, in which the 210-300° C. fraction of the liquid-phase product is vaporized in a stream of hydrogen and passed through a bed of catalyst particles. The temperature and time of contact in the liquid phase are 450° C. and 2 hours, and in the vapor phase, 510° C., and 0.5 minute, respectively. Among the substances produced are: phenol, cresol, benzene, toluene, xylene, tetrahydronaphthalene, cyclohexane, methylcyclonexane, dimethylcyclohexane, high-flash naphtha and oil distilling under 207° C. Methods used in the work are described in considerable detail, and numerous tabulations of the results are presented.

Products: Properties and Utilization

Determination of Total Water-Soluble Chlorides in Petroleum, J. W. HORNE AND L. F. CHRISTIANSON, *U. S. Bur. Mines, Rept. Investigations* **3517** (1940) 10 pp.

A measured sample of oil is diluted with xylene to dissolve wax, gum and asphalt. A stabilizer is added to prevent or resolve any emulsion that may be formed. Hot distilled water is added and the mixture heated and agitated vigorously to dissolve the salt. Separation of the oil from the water is made by centrifuging. The water is titrated with silver nitrate. The method is simple, requires little apparatus and time, and can be used for the chloride determination in oils with paraffin, naphthene or intermediate base. It is possible to determine the salt with an accuracy of ± 2 pounds per 1000 barrels of oil, whether the salt is present as an emulsified brine or as microscopic crystals.

Organic Halogen Compounds in Mineral Oils, M. S. AGRUSS, G. W. AYERS, JR., AND H. SCHINDLER, *Ind. & Eng. Chem.* Anal. Ed. **13** (1941) pp. 69-70.

In recent years the addition of organic halogen compounds to various mineral oil products has become a common practice. Among such products are: fireproof cleaning solvents, cutting oils, break-in oils, and special lubricants. In most instances the halogen compound is a chlorine compound. The authors describe a method for the determination of total halogen in the oil, the determination of the type of halogen compound, i.e., whether

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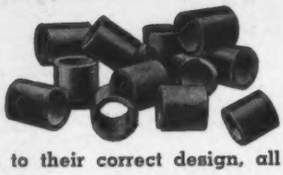

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chlorine is attached to an aromatic ring, and finally, the possible identification of the halogen compound present.

Determination of Bromine Addition Number, K. UHRIG AND H. LEVIN, *Ind. & Eng. Chem.*, Anal. Ed. **13** (1941) pp. 90-2.

The methods for the determination of unsaturated hydrocarbons in the presence of aromatics, naphthenes and paraffins are briefly reviewed. They found that the bromine number determined is a function of the excess of bromine present, and also that the solvent in which the sample is dissolved and that in which the bromine is dissolved is important. The method found to be satisfactory is a direct titration of the sample dissolved in chloroform using a standard solution of bromine in glacial acetic acid, and using the color of the bromine itself as indicator. The method has been found to give correct results when applied to pure hydrocarbons of known unsaturation, such as cyclohexene, diisobutene, triisobutene, etc. The method gives reproducible results with a given sample.

Measurement of the Resistance of Oil Asphalts (50-60 Penetration) to Changes in Penetration and Ductility at Plant Mixing Temperatures, C. L. SHATTUCK, *Assoc. Asphalt Paving Tech.*, Proc. Tech. Sessions **11** (1940) pp. 186-203.

Data based on asphalts recovered by the Abson method from pavements of various ages in Detroit indicate that recovered asphalts with a ductility below 25 cm. at 77° F. all came from badly cracked pavements, regardless of their penetration at 25°. The author proposes a test to determine the drop of ductility on heating to insure the use of asphalts suitable for bituminous-pavement construction. A small pug mixer used is described in detail. It is heated to an inside temperature of 275° to 300° F., charged with 1880 grams of standard Ottawa sand heated to 400° F. and 120 grams of oil asphalt at 300° F. These are mixed for 1 minute at 75 r.p.m., spread evenly in a metal pan 7 x 11 inches, and placed in an electric oven at 350° F. for 30 minutes. The mixture is cooled and extracted with benzene. The asphalt is recovered by the Abson method. Penetration and ductility determinations are then made on the asphalt so recovered.

The Kinetics of the Decomposition Reactions of the Lower Paraffins. VII. The Nitric Oxide-Inhibited Decomposition of Ethane, E. W. R. STEACIE AND G. SHANE, *Can. J. Res.* **18, B** (1940) pp. 351-7.

Thermal decomposition of ethane inhibited by nitrous oxide was studied. The activation energy of the inhibited reaction is 77.3 kilogram-calories. The results are discussed and the conclusion reached that the thermal decomposition of ethane proceeds mainly by a rearrangement mechanism and that free-radical chain mechanisms for ethane decomposition are untenable.

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O. D. Donnell, president of The Ohio Oil Company, Findlay, Ohio, has been named chairman of the American Petroleum Institute's 1941 Central Power Committee. D. V. Stroop, of the institute staff, is secretary. Members are: C. C. Ashley, Shell Oil Company, San Francisco; Frank Fox, Standard Oil Company of New Jersey, Elizabeth, New Jersey; Lester M. Goldsmith, The Atlantic Refining Company, Philadelphia; W. C. Poole, Sinclair Refining Company, East Chicago, Indiana; R. C. Powell, The Texas Company, New York; F. E. Richardson, Great Lakes Pipe Line Company, Kansas City; A. H. Riney, Phillips Petroleum Company, Bartlesville; Richard Sanders, Magnolia Petroleum Company, Beaumont, Texas; Warren A. Sinsheimer, Petroleum Advisers, Inc., New York; and Henry Thomas, Sun Oil Company, Philadelphia.

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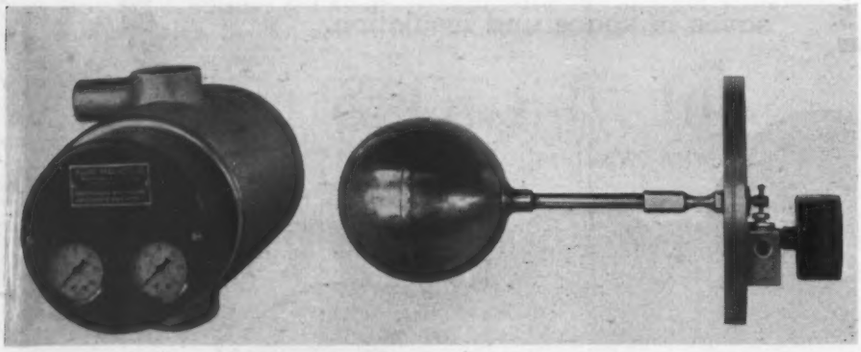

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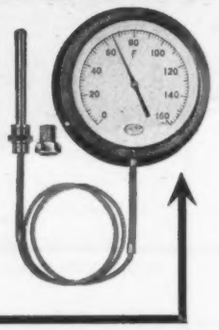

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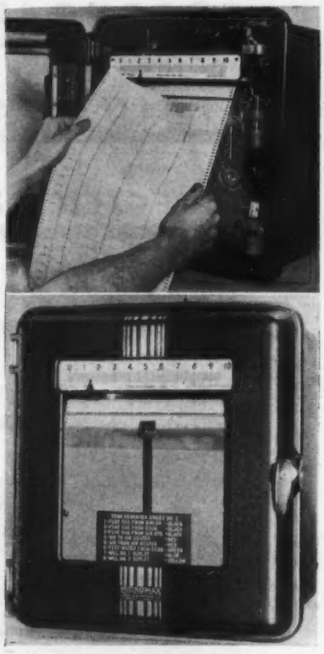

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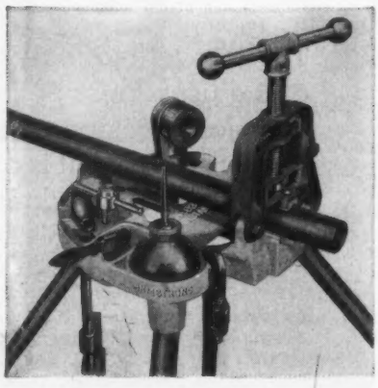
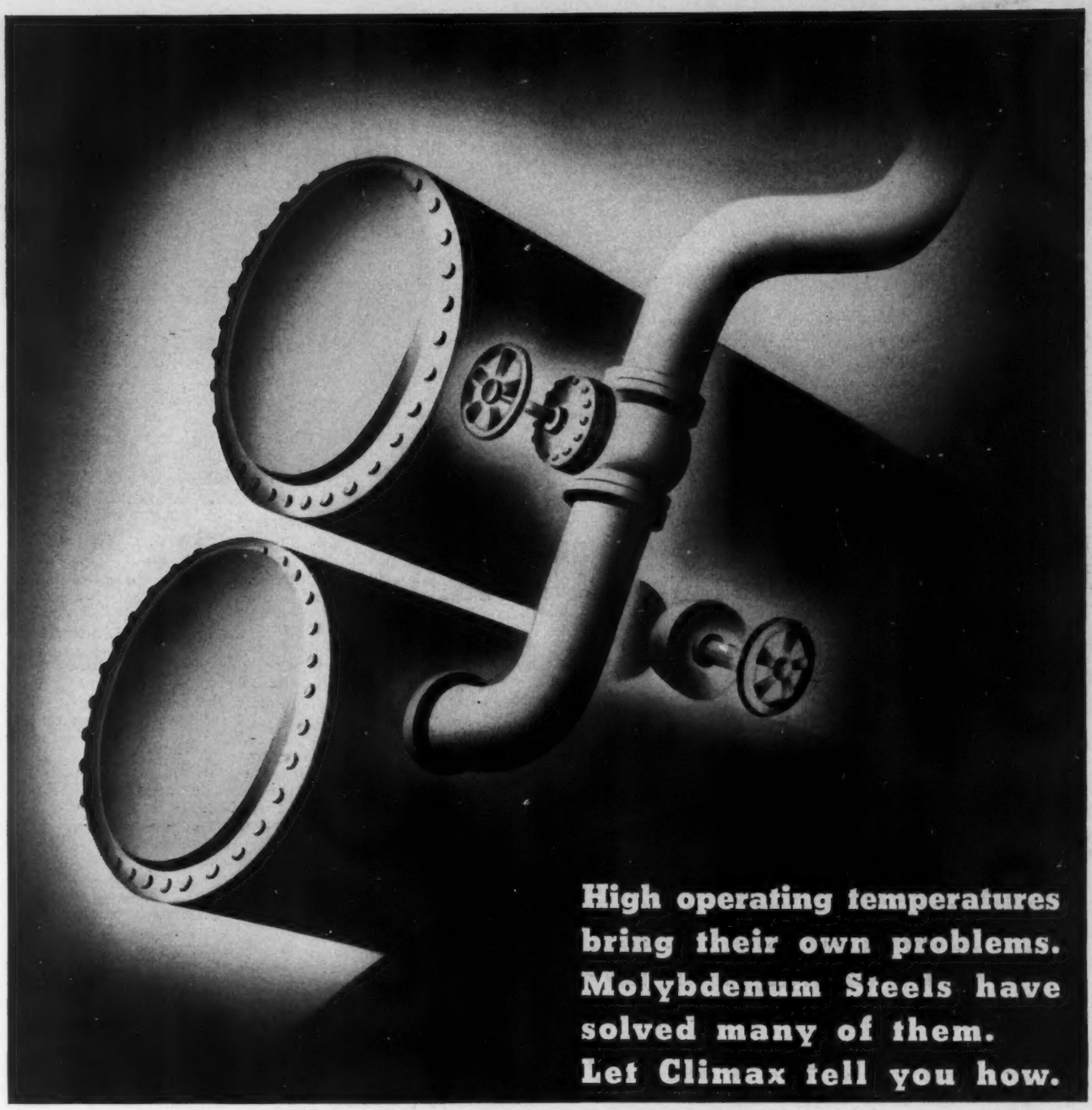


Armstrong Type 933 Vistand



Whether refinery heat exchangers are money makers or money wasters depends largely on the material of which they are made.

Those of Chromium-Molybdenum (4–6% Cr) steel have proved to be the former. The steel has exactly the requisite properties: adequate strength at operating temperatures, with no susceptibility to temper brittleness, and good corrosion resistance. Its use lengthens the effective life of heat exchangers and minimizes the possibility of production-interrupting failures.

For complete data on this and other heat resisting Molybdenum steels for refinery use, see section 8 of our free technical book, "Molybdenum in Steel".

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • CALCIUM MOLYBDATE

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MOLY

front, and 43 inches from front to rear leg to prevent tipping. The platform, which measures 14 inches in both width and depth, features tool notches and slots around the rim, an oil can recess, and a dope pot. Equipment includes three benders, one for ¾-inch pipe, and reverse benders for ½- and ¾-inch pipe, all placed directly over the right front leg.

The stand has a ceiling brace. Feet are punched for attaching to the floor, or they may be equipped with skidless rubber shoes to prevent scratching a polished floor. The vise has a new screw with frictionless disk to protect the tip.

A one-piece slide rides on the outside of the frame. Vise jaws are heat treated, with teeth spaced to hold each size of pipe. Each tooth is undercut to prevent it from filling up with scale.

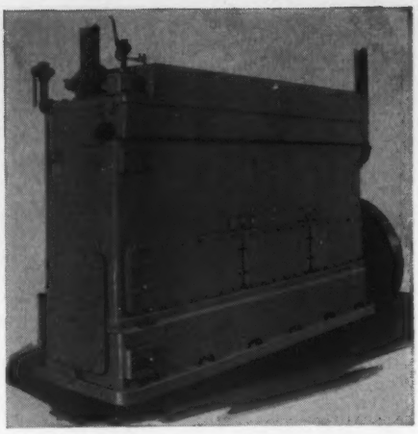
Gas Engine

THE BRUCE-MACBETH ENGINE COMPANY

A line of heavy-duty gas engines, designated type G and designed with all moving parts enclosed except the flywheel, has been announced by The Bruce-Macbeth Engine Company, 2111 Center Street, N. W., Cleveland.

Design of the unit permits accessibility to moving parts for inspection or adjustment. Cooling is without a water jacket, parts requiring cooling being submerged. Overflow pipes are designed to maintain a constant required water level and to provide for complete circulation and a uniform engine temperature. An air starting system is provided.

The engines operate on gas of any heat value from 125 to 3000 Btu. per cubic foot. They are available in a 3-cylinder model at 90-horsepower; 4-cylinder at 120-horsepower, and 6-cylinder at 180 horsepower.



Bruce-Macbeth Type G Engine

Packing

GREENE, TWEED & COMPANY

A high-pressure spiral packing, with the outer layer impregnated with lubricant forced into it by a hot-pressure process, has been announced by Greene, Tweed & Company, 101 Park Avenue, New York.

The packing is made of closely woven asbestos cloth with center block laid up against a flat strip of heat-resisting, resilient red rubber. The cover or wear face is bonded to the center to make a square-cornered packing, which is spiraled on a mandrel and vulcanized to retain its shape, and the lubricating process applied.

The resulting construction is designed to combine ruggedness and resilience to withstand misalignments and impact shocks, and to provide lubrication to reduce wear on the rod or shaft and prolong the life of the packing.

The packing is furnished in standard 12½-foot spirals.

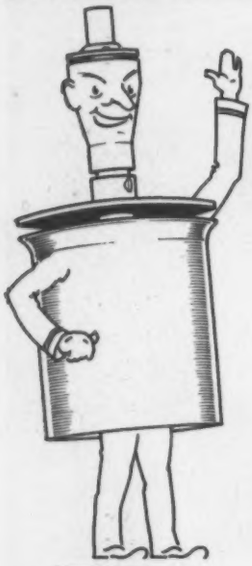
Conversion Carburetor

CLAYTON CARBURETOR SALES

A carburetor for converting gasoline engines to use of natural gas or butane has been announced by Clayton Carburetor Sales, Box 1052, Wichita, Kansas.

The device connects to the air in-take of the gasoline carburetor, and is designed to use either natural or butane gas delivered to the regulator at from 4- to 20-ounce pressure, and then to automatically adjust the fuel content and

Clayton Carburetor



John Zink BI-MIX BURNERS

"Can't be beat for gasoline plants"!

Giving heat without flame, they burn with a very short flame without excess air, refinery gases, residue gas, and natural gas. A large majority of the permanent gasoline plant boilers are fired with the John Zink Vertical Bi-Mix Burners.

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JOHN ZINK COMPANY

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JERGUSON Gages

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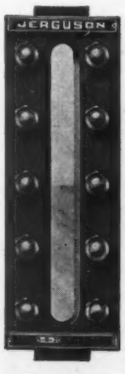
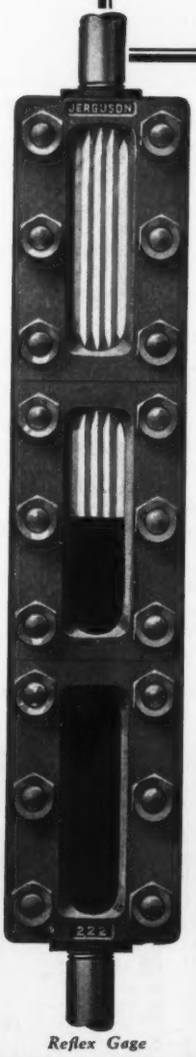
TRANSPARENT

In Your Estimation,

JUST HOW IMPORTANT IS THE COLUMN GAGE?



Transparent Gage



Reflex Gage

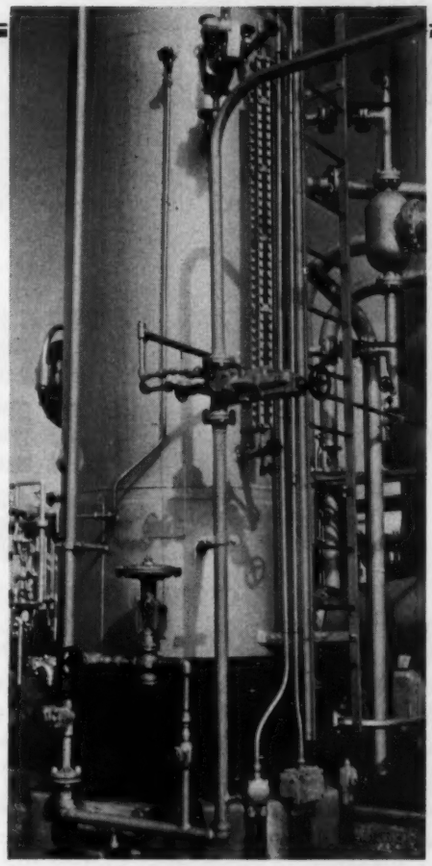
Is it merely a gadget by which you can get some idea as to liquid levels—if you get close enough? Is it a fitting to which little thought need be given to safety factors?

Having lived with this type of accessory for years we certainly don't under-estimate its importance —both as to design and use.

Why, for example, did we long ago go to forged steel chambers and alloy steel covers? Why have we given so much care to the selection and tempering of the glass? Why have we designed these gages so that they can be incorporated in existing "water column" hook-ups?

WHY? Because we believe you will want the most practical, most effective and safest gage you can get for the all-important work of indicating liquid levels.

Make it JERGUSON the next time you buy gages.



JERGUSON GAGE & VALVE CO.

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Chester, Pennsylvania

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Tulsa, Oklahoma

O'Brien Equipment Co.
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Associated Valve & Engineering Co.
510 North Dearborn St.
Chicago, Illinois

H. R. Bowers
1758 Wright Ave.
Rocky River Branch
Cleveland, Ohio

J. Arthur Moore
342 Madison Ave.
New York, N. Y.

The J. A. Rossiter Co.
Houston, Texas

Murray-Baker-Frederic, Inc.
620-630 South Peters St.
New Orleans, Louisiana

Paul B. Huyette Co., Inc.
401 North Broad St.
Philadelphia, Pennsylvania

pressure for delivery to the carburetor part.

In operation, the engine is run with the regular throttle. The regulator opens up automatically when the motor speeds up, and closes automatically when the motor slows down.

Circuit Breaker

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

A new enclosed circuit breaker designed for protection of all types of light and power circuits, designated De-ion Type AB-1, has been announced by Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania. It is available in four frame sizes, in ratings from 15 to 600 amperes and in steps corresponding to commercial wire sizes. All sizes are available with ratings from 250 volts AC and 125/250 volts DC to 600 volts AC and 250 volts DC.

The circuit breaker features silver contacts operated by a toggle mechanism to provide a quick make-or-break action; bimetal thermal elements to prevent tripping due to harmless overloads, rust and corrosion resisting metal parts, and a method of arc quenching to confine, divide and extinguish the arc almost instantly as the contacts open, providing long contact life and reducing fire hazard.

A complete line of the breakers is available for hazardous locations classified by the national electrical code and by Underwriters Laboratories as Class I, Group D and Class II, Group G.

Thermocouple Furnace

LEEDS & NORTHRUP COMPANY

A thermocouple checking furnace, designed to provide a zone of practically uniform temperature for intercomparison of laboratory standard couples and for comparison of laboratory standard and plant standard couples, has been announced by Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia.

The unit employs a cylindrical copper equalizing block that fits inside the furnace to increase accuracy of checking. Drilled into the block are five wells to hold the comparison standard and four couples for checking. With the equalizing block, checks can be made within ±1° F. from room temperature up to 1000° F., and without the equalizing block, from within ±3° F. over a range of 300° to 1800° F.

Available with heating elements for either AC or DC operation on 115 or 230 volts, the furnace requires an input ranging from 40 watts at 300° F. up to 1000 watts at 1800° F. When temperature must be raised rapidly, input can be increased to 5000 watts.

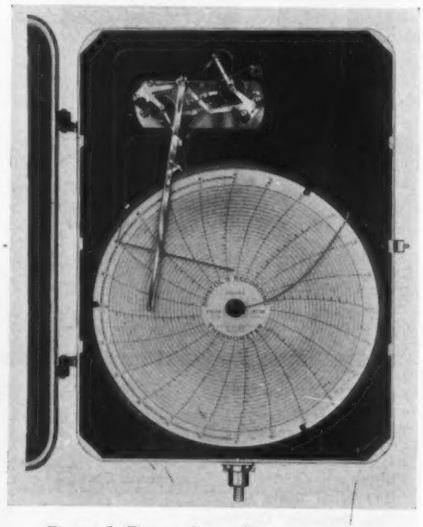
Working space inside the furnace is four inches in diameter and 36 inches deep. Outside diameter is 14¼ inches.

Recording Thermometer

THE BRISTOL COMPANY

Two recording thermometers of the liquid-filled type, designated case-compensated class 1 recording thermometer and fully-compensated class 1 recording thermometer, have been announced by The Bristol Company, Waterbury, Connecticut.

The case-compensated instrument is offered in temperature ranges up to 400° F. and tubing lengths up to 10 feet or longer, depending upon conditions surrounding the installation. The fully-compensated thermometer may be had in ranges up to 400° F. and equipped with 200 feet or less of connecting tubing between the instrument and the bulb.

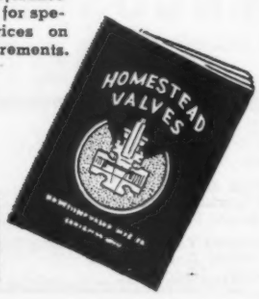


Bristol Recording Thermometer

THE VALVE REFINERS ASKED FOR!

The exclusive Homestead "Lever-Seald" Valve principle with its controlled, adjustable lift, assures operation under **all** conditions. Extremes of temperature and pressure, infrequent operation, and other conditions which cause ordinary valves to "freeze" or stick, never faze these valves. They **always** operate! Their powerful leverage prevents sticking, and provides a leakless seal without lubrication. In addition, a quarter-turn of the upper lever fully opens or closes; seating surfaces are protected; and straight line flow assures minimum pressure drop. Homestead Lever-Seald Valves are made in the proper metals for maximum valve life under each refinery service condition. Extra long life and extremely low up-keep combine with these special features to make "Homesteads" a logical choice for refinery use. Write your needs for recommendation today.

Send for Valve Reference Book No. 38; and for special quantity prices on your valve requirements.



HOMESTEAD VALVE MFG. COMPANY

P. O. BOX 16, CORAOPOLIS, PA.

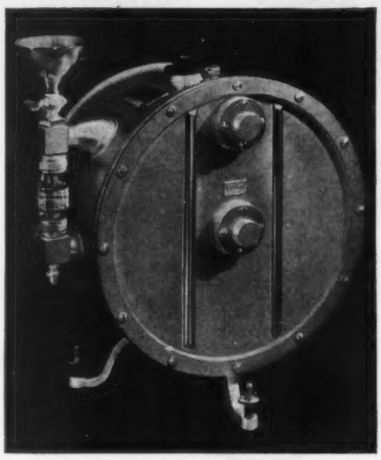
HOMESTEAD VALVES

Meter

AMERICAN METER COMPANY

A removable back head to facilitate cleaning and make easier access to the drum of its wet-test meters has been announced by American Meter Company, 60 East 42 Street, New York.

When specified, it may be had with any of the company's A1-18 series for



American Meter Removable Back Head

general laboratory testing and for calorimetry, including both low- and high-pressure models.

The back head assembly may be attached to meters already in service with either flat or convex back heads.

Motor

GENERAL ELECTRIC COMPANY

A tri-clad capacitor motor has been announced by General Electric Company, Schenectady, New York.

It may be obtained with either ball-bearing or sleeve-bearing construction, and is available in two types, Type KC and Type KCJ. Type KC is designed particularly for applications requiring moderate starting torques such as fans, blowers, and centrifugal pumps. Type KCJ is designed for compressors, loaded conveyors, reciprocating pumps, and any other applications requiring high starting torque. Capacitors are mounted inside the end shield on the normal-torque motor, while on the high-starting torque motor, 1½-horsepower and larger, capacitors are mounted in a case on top of the motor frame.

In both of its forms, the capacitor motor features mechanical protection through the use of a cast-iron frame, electric protection by use of Formex wire in the magnet coils, and improved bearing design and lubricating arrangements. It also utilizes cast-aluminum rotor and double-end ventilation.

Protected frame and end shields are designed to minimize contact of vital motor parts with foreign material while also protecting it against accidental blows in handling or similar rough usage. New-type insulation, dust-tight bearings, and the use of Glyptal in the priming and finishing paints armor it against the attack of harmful agents.

The transfer switch, transferring the motor from the starting to running connection, consists of a centrifugal mechanism mounted on the rotor shaft, and a stationary switch located in the end shield. As the motor approaches full speed, centrifugal force moves the collar of the rotating mechanism away from the switch by snap action, thus causing the switch to open.

A new pressed-steel conduit box is designed to provide large working space and simplify installation in close quarters.

G-E capacitor motor. End shield shows capacitors and transfer switch

Flow Controller

FISCHER & PORTER COMPANY

A flow control device to provide a means of splitting a flow in definite proportions regardless of fluctuations in the total incoming flow, designated Rotaweir, has been announced by Fischer & Porter Company, County Line Road, Hatboro, Pennsylvania. It is available in all-metal and pyrex shell models.

The device is designed to proportion delivery and reflux flow, maintaining a set proportion on varying flow from the condenser between 100 and 2500 gallons per hour. Delivery is proportioned by turning a crank over a graduated dial on the side of the housing.

Either a glass cylinder or a metal shell between a top plate and a base casting forms the housing, and inside it

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High speed, low spatter loss, easy slag removal and smooth bead qualities also distinguish these electrodes.

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For high grade welding of carbon steels. A shield-arc type, 3-position electrode. Get your copy of interesting booklet.

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For high strength, heavy duty welds in carbon steel. Shield-arc type, 3-position electrode. Ask for booklet.

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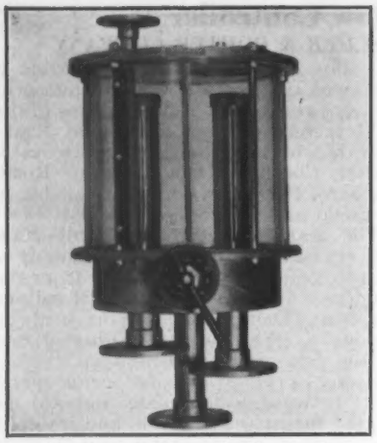
ACCO

AMERICAN CHAIN & CABLE COMPANY, Inc.



Fischer & Porter's Rotaweir

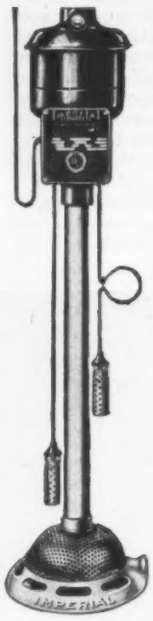
are two upright cylinders. Each cylinder is in double construction with an inner and an outer shell. The outer units fit closely to the inner ones and are connected to rotate on them by a gear connection to the adjusting crank on the outside of the assembly. The rotating movement serves to open or close a rectangular weir slot in one of the two assemblies, and at the same time to close or open an identical slot in the other. These slots provide passage for the distillate to delivery on one side and to reflux on the other.

Inlet from the distilling equipment is through the central one of the three connections on the bottom of the unit's housing, the liquid rising inside the housing to surround the two cylinder assemblies. Flow then is through the slots to the two outlet connections at the bottom in proportion to the amount that they stand open. Should delivery into the unit increase or decrease, the liquid rises or falls inside the housing without affecting the set proportion through the two outlets. A vent connection is provided at the top of the assembly to prevent buildup of pressure in the housing.

Sump Pump

THE IMPERIAL BRASS MANUFACTURING COMPANY

A line of sump pumps, employing a new type forged impeller to increase pumping capacity, has been announced by The Imperial Brass Manufacturing Company, 1200 West Harrison Street, Chicago.



Imperial's Sump Pump

All models are powered with General Electric Company ¼ horsepower motors with oil-sealed ball-thrust bearing for vertical operation. The motor is started and stopped automatically by two electrodes. The pump is designed to pump down to within 2¾ inches of sump bottom.

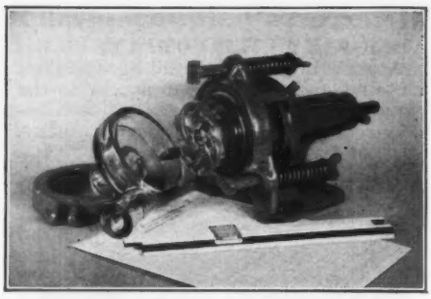
Models available are designed to work in sumps of 2, 3, 4, 6 and 8 feet in depth, and all are rated to move 3650 gallons an hour against total discharge head of 5 feet, 3200 gallons against head of 10 feet, 2660 gallons with 15-foot head; 1840 gallons with 20-foot head; 1350 gallons with 22-foot head, and 500 gallons with 24-foot head.

Pump

NASH ENGINEERING COMPANY

A pump employing Pyrex glass, ¾ x 1-inch with a capacity of 10 gallons per minute, has been announced by Nash Engineering Company, South Norwalk, Connecticut. The unit is designed for small installations, and for laboratory and pilot-plant service.

The pump is fully transparent. A mechanical seal replaces the conventional



Nash Engineering's Glass Pump

stuffing box, and a safety unloading device is designed to eliminate the possibility of fracture of the glass casing. The pump is designed to handle acids or brine, hot or cold, with equal facility.

Relief Valve

J. E. LONERGAN COMPANY

A bronze body relief valve for bypass service has been announced by J. E. Lonergan Company, 211 Race Street, Philadelphia.

Both inlet and outlet openings are cast in the same flange.

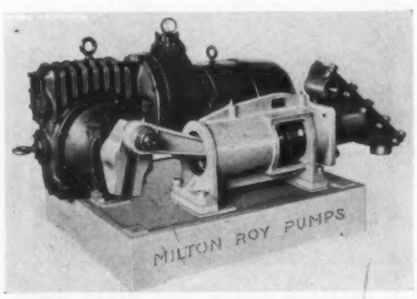
Step-Valve

MILTON ROY PUMPS

A step-valve for pumps, designed to make the interior of the valve-body accessible for cleaning by removal of a single, flat cover plate, has been announced by Milton Roy Pumps, 1315 East Mermaid Avenue, Philadelphia.

The valve is constructed to automatically discharge all air and eliminate air-binding, to discharge small particles of dirt, and to permit cleaning, when necessary, with a minimum of time and effort.

The valve is being made available on the company's line of pumps for han-



Pump with New Step-Valve

E V

EDWARD

HIGH PRESSURE

Drop Forged Steel Valves

Trimmed with "EValloy" Stainless Steel

Figure 2688

These valves are suitable for pressures up to 6,000 pounds. Catalog No. 11-G, covering complete details on the Edward Valve line is available to you, upon request.

GLOBE • ANGLE • BALL CHECK • NEEDLE • METER

Large Stocks in sizes ⅛" through 2" carried in our Houston Warehouse

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dling acids, alkalis, boiler-treating chemicals, oil-refinery products and other liquids against pressures up to 20,000 pounds or more, and also on proportioning pumps and pumps with valve bodies made of transparent plastics.

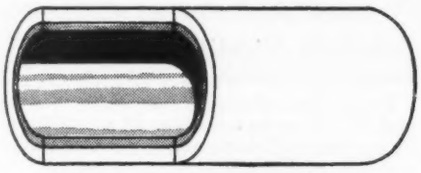
Duplex Tubing

BRIDGEPORT BRASS COMPANY

A duplex tubing, designed for heat exchanger tubes or piping subjected to two different types of corrosive attack, has been announced by Bridgeport Brass Company, Bridgeport, Connecticut.

The tubing is available in a combination of metals to meet specific conditions, and in processing a close contact is obtained to prevent serious interference with heat transfer.

Where tubes have to be expanded or rolled into a tube sheet, they may be



Bridgeport's Duplex Tubing

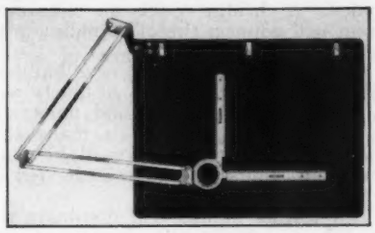
obtained with annealed or tempered ends suitable for this operation. The tubing is available in sizes up to and including 2-inch outside diameter.

Drawing Machine

THE DRAFTO COMPANY

A line of portable drawing machines, taking paper sizes from 9x12 inches to 18x24 inches, has been announced by The Drafto Company, Walnut Street, Cochranton, Pennsylvania. All models are mounted on Masonite board, with parallel arms and protractor place constructed of stainless steel.

Two small models, designated Nos. 10 and 15 and taking paper sizes 9x12 and 10x15 inches, feature scales made in one piece, permanently attached to the protractor plate. The protractor for these models is graduated in 2-degree units,

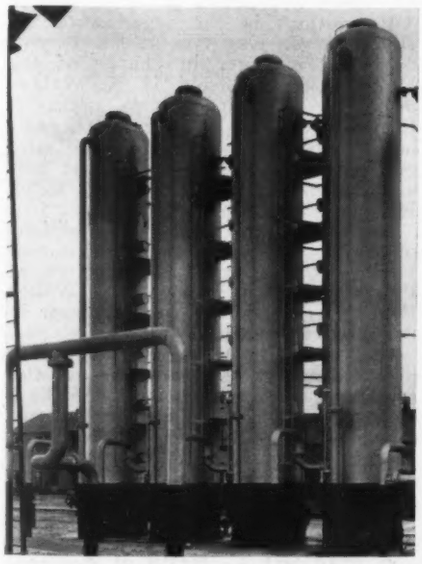


Drafto Company's Drawing Machine.

and clamping device is designed to provide equal locking tension at all angles to prevent slippage.

Two larger sizes, Nos. 30 and 35, have a capacity for drawings to 12x18 and 18x24 inches. Protractors are equipped with a vernier so that the machine can be set to ½-degree readings. A latching device is provided to lock the scales at 0-, 30-, 45-, 60- and 90-degree readings on either side of the 0-degree readings. Models Nos. 30 and 35 are equipped with detachable scales.

The No. 10 unit is supplied in one model, No. 15 is supplied in two models. There are three models in the No. 30 unit, and four models are included in the No. 35. All models use chromium steel with bright finish in the parallel arm assembly, with dull chromium finish employed on the protractor device. Assembly of each unit is completed with clips along the top edge to hold drawing paper and tracings.



These absorbers were fabricated by Wyatt Metal & Boiler Works, Houston, for Shamrock Oil & Gas Company for gasoline plant operation at Sunray, Texas. They are 84 inches by 42 feet, and are rated for 400 pounds working pressure.

AIRETOOL
REFINERY
SPECIALTIES

You're acquainted with the line of powerful Airetool Tube Cleaners (½" to 20" I.D.), the rugged Airetool Tube Expanders (7 types) and the safe Airetool Catalyst Tube Cleaning System. Now look over a few other Airetool Refinery Specialties that may not be so familiar but can be important labor savers for you.

BUFFING MOTORS for buffing any type seat or plug.

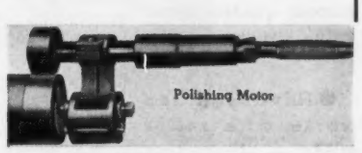
POLISHING MOTORS for grinding or polishing ends of tubes.

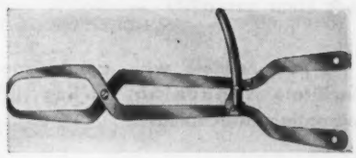
CALIPERS for checking I.D. of tube ends and the thicknesses of headers, fitting walls and valve bodies.

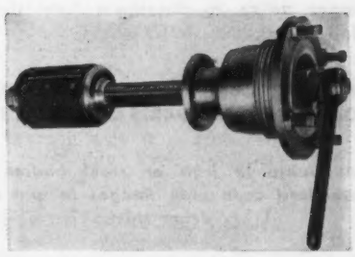
I.D. TUBE GAUGES in three types ranging in size from 2½" to 10".

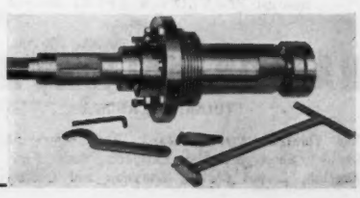
FLYCUTTER for machining end of tube after rolling, and for removing a bad tube without burning it out. A form of this tool is made to remachine header or serrations on the job without removing header.

TUBE JIG to hold tubes in position and alignment during the rolling operation.









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BUSINESS NOTES

Sterling Engine Company Starts New Buffalo Plant Construction

Construction work has started on a $500,000 addition to Sterling Engine Company's plant at Buffalo, according to Addison F. Vars, president. The new building, providing about 75,000 square feet of floor space, will be ready by September and will be used for assembling and testing of the company's Admiral engines.

Specifications call for a three-story and basement steel frame structure, with brick and tile walls, and re-enforced concrete floors. It will be 440 feet long and from 40 to 82 feet in width. A one-story and basement wing is also included. A bridge over an adjoining street will connect the old building with the new.

The third floor of the new building will be used for storage of parts and subassembly. On the second floor will be two assembly lines. To make this floor dustproof, windows will be non-operating, and fresh air will be fed in through filtered ducts.

Ten testing stands will dominate the first floor, which will also accommodate the painting and shipping departments. The engines under test will be completely enclosed; they will be operated from an adjacent control room in which test recordings will also be made. The engine test cells will be treated for both sound transmission and sound absorption.

ANNOUNCING

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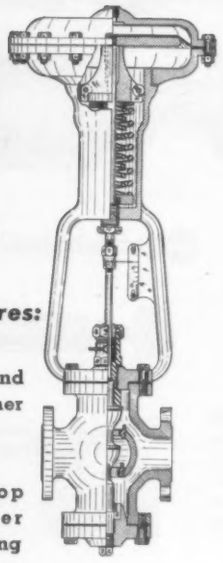

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Keratol Company Now Division Of Atlas Power Company

The Keratol Company last week announced that business, assets and good will of the company had been acquired by Atlas Power Company, and will be operated as the Zapon-Keratol Division of the latter company.

The Keratol Company organization, personnel and policies are being continued in the new division and under the same management, with headquarters at Newark, New Jersey.

Tulsa Exhibition Pushes Plans for 1942 Show

Plans for Tulsa's 1942 International Petroleum Exposition are going ahead as usual, oil show officials said when informed that the Houston Oil-World Exposition had been postponed until 1943.

Committees are at work planning exhibits for the enlarged Hall of Science, under the direction of Dr. Gustav Egloff, research director of the Universal Oil Products Company of Chicago, said W. G. Skelly, exposition president.

Skelly said that 264 exhibitors have requested approximately 56 percent of the available space, although no effort yet has been made to sell space.

Pittsburgh Equitable Meter Acquires National Meter

Pittsburgh Equitable Meter Company, Pittsburgh, last week announced purchase of National Meter Company, Brooklyn, which will be operated as a division of the Pittsburgh company.

There is no overlapping between the products of the two companies, and the purchase makes available nine types of meters, including flat and conical nutating disc; oscillating, reciprocating and rotary piston; screw-propulsion; current and compound types. Structural differences and design features in meters identified by trade names will be continued as the Pittsburgh-National line.

No changes are contemplated in personnel.

National Meter Company was founded in 1870 by John C. Kelley. Associated with him from the beginning was Dr. Lewis H. Nash, to whom were granted 92 patents on liquid meters. For the past 71 years this firm has been manufacturing meters exclusively.

Pittsburgh Equitable Meter Company was founded as Pittsburgh Meter Company in 1887 by the late George Westinghouse.

Grove Regulator Company in New Plant at Oakland

Grove Regulator Company has moved into new modern offices and plant at 1190 67 Street, Oakland, California. The structure provides enlarged engineering, production and testing facilities.

The factory features a complete testing laboratory manned by staff of chemical and metallurgical engineers. A 10,000-pound hydraulic testing unit and an automatically controlled testing boiler capable of developing heat temperatures up to 1000° F. and 2000 pounds pressure, have been installed. Nearing completion is a heat treating furnace to insure closer supervision and greater uniformity of the company's high-pressure regulators.

A further addition which will increase the present floor area is contemplated.

Industrial Scientific Acquires Industrial-Scientific Supply

Industrial Scientific, Inc., Fort Worth and Houston, has announced acquisition of Industrial-Scientific Supply Company division of Fort Worth laboratories.

Principals of the company are B. H. Wilson, Roy E. O'Neill and Fred Wellborn, who will continue sales and service of Taylor instruments, Pyrex and Kimble glassware, Baker & Adamson reagent chemicals, Marsh gauges and laboratory apparatus and equipment.

Offices are being maintained at 828½ Monroe Street, Fort Worth, and at 1302 Dallas Avenue, Houston, with stocks at both locations.

D. W. Haering Increases Sales And Service Facilities

Increased sales and initiation of a broadened service representation plan have necessitated addition of several chemists and engineers to the service organization of D. W. Haering & Company, 2308 South Winchester Avenue, Chicago.

Promotions in the organization include H. C. Daggett, named eastern divisional manager in charge of the New York office, and D. R. Walser, promoted to Chicago area manager. E. V. Zellers and P. V. Sanders, engineers, were added to the Chicago sales organization, and C. La Follette was made sales engineer at South Bend, Indiana.

Eastern expansion includes additions of W. E. Schaffnit at Philadelphia, and J. B. Cropsey, with headquarters at Pomfret Center, Connecticut. Walter Peffer was appointed sales engineer in the Pittsburgh territory.

G. I. Thomas, Dallas, has been added to the staff of representatives in the southwest. A new office at 755 East Gage Avenue, Memphis, has been established with J. W. Gibson as sales engineer in charge. R. A. Jens has been made sales engineer in the Twin City area with headquarters at 588 Glendale Avenue, St. Paul. Southern representation has been increased with the addition of Albert C. Heath at Ashland, Virginia. Canadian expansion includes the addition of R. L. Collins, sales representative at Toronto.

R. M. Place has been added to the staff of chemists at the Chicago laboratory to assist in an expanded research program.

Metal Hose & Tubing Moves Plant Under New Setup

Metal Hose & Tubing Company, Brooklyn, New York, has announced a reorganization and removal of its general offices and factory to Dover, New Jersey.

Employes of the company, founded in 1912, have purchased the business from the estate of John M. Oden, company founder who died in 1938. The company will be run by an executive committee consisting of A. L. Wallace, vice president; W. D. Magagnos, treasurer, and J. S. Thompson, sales manager.

Removal of the plant was necessitated by inclusion of the old factory site in a federal housing project. The new factory building is modern, fireproof, and includes over 110,000 square feet of space on two floors.

Mine & Smelter Supply Company Named New Gisholt Sales Agent

Gisholt Machine Company, Madison, Wisconsin, has announced appointment of The Mine & Smelter Supply Company, Denver, as exclusive sales agent in the Rocky Mountain region. Through its Denver office and branch offices in Salt Lake City and El Paso, the representative will handle the territory consisting of Arizona, Colorado, New Mexico, Utah, Wyoming, Republic of Mexico and portions of Idaho, Kansas, Montana, Nebraska, South Dakota and Texas.

Welding Rod Production Capacity Termed Adequate

Manufacturers of electric arc welding rods, discussing production capacity at a meeting held in Cleveland last month, declared that, with installation of a relatively small amount of new equipment, there will exist ability to produce approximately 400,000,000 pounds of welding rods annually, roughly twice the quantity used during 1940.

Supply Personals

D. E. Buchanan, president of Hanlon-Buchanan, Inc., has accepted the general chairmanship of the entertainment committee for the mid-year meeting of the American Petroleum Institute, to be held in Tulsa, May 19-22.

P. L. Griffiths, former treasurer of the overseas division of General Motors Company, has been elected vice president of Ethyl Gasoline Corporation. He will head the financial department.

Carlton B. Smith, former Southeast district service engineer for Allis-Chalmers Manufacturing Company, has been promoted to district superintendent of service and erection with headquarters in the Healey Building, Atlanta, Georgia.

R. E. Spencer Geare, has become affiliated with Thermoid Rubber Division of Thermoid Company, Trenton, New Jersey. He has specialized in the V-belt field for the last ten years.

Newton P. Selover, who has represented the Locomotive Equipment Division of Manning, Maxwell & Moore, Inc., on the Pacific Coast for the past seven years, has been named western sales manager, with headquarters in Chicago.

Stewart J. Hieronymus, with Cutler-Hammer, Inc., for 12 years, has been appointed sales engineer at San Francisco for The Lincoln Electric Company, Cleveland.

Bob Sivalls, for the past several months in charge of the branch of Black, Sivalls & Bryson, Inc., at Ardmore, Oklahoma, is returning to Jackson, Mississippi, to take charge of the Company's branch there. He is being replaced at Ardmore by Ed Nelson, formerly at the company's Oklahoma City office.

A. E. Bateson, who until a year ago was manager of purchases for Allis-Chalmers Manufacturing Company, Milwaukee, has retired after completing 50 years of service with the company. He was born in England and came to this country at the age of four. In 1891, he entered the employ of the purchasing department of Fraser & Chalmers, Chicago, which was consolidated with E. P. Allis Company in 1901 to form Allis-Chalmers Company. He was succeeded in January, 1940, by F. E. Haker, who at that time was appointed manager of all the company's purchasing activities.

J. B. O'Connor, vice president and sales manager of Clark Bros. Company, Olean, New York, left Miami last month on a plane tour of South American oil territories. Mrs. O'Connor accompanied him. In their all-air trip, the O'Connors will include stops in Buenos Aires, Rio and Port-of-Spain. Theirs is a combined business trip and vacation. O'Connor's objective is to make a gen-

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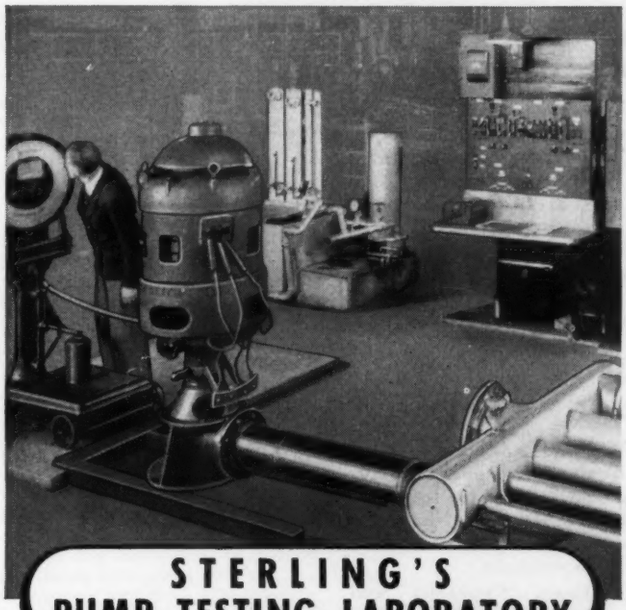

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eral survey of the oil situation in the South American fields. The trip will occupy about a month.

F. W. Morris has been appointed sales manager for the Dayton Coupling Division of the National Supply Company. He had been associated with the Spang-Chalfant Tubular Sales Division since July 15, 1925, and for the past three years, has been located in Philadelphia, Pennsylvania. He will make his headquarters at Pittsburgh.

F. H. Lindus, formerly Los Angeles branch manager in charge of the service-sales division of The Timken Roller Bearing Company, has been transferred to the company's home office at Canton, Ohio, where he is engaged in general sales promotional work. L. J. Halderman, branch manager of the service-sales division of the Chicago office, has taken Lindus' place at Los Angeles, while Jack Gelomb, formerly Detroit manager of the service-sales division, has filled the vacancy in the Chicago office. Joe Jesseph, resident salesman at Portland, Oregon, has taken Gelomb's place in the Detroit office.

Charlie Williams, formerly stationed at Alice, Texas, for Black, Sivalls & Bryson, Inc., has been transferred to Odessa, where he replaces Earl Darr, who has been called for military service.

W. F. Rockwell, president of Pittsburgh Equitable Meter Company and Merco Nordstrom Valve Company, has been named to serve on the national committee of business welfare of the Chamber of Commerce of the United States. The committee has been named to further the aims of the chamber through objectives designed to solve serious problems affecting business and the general welfare.

W. F. Rockwell

J. C. Merwin, vice president and treasurer of Chain Belt Company, Milwaukee, has been named president of the company, succeeding C. R. Messinger, who died February 4. He joined the company in 1917, and has been successively superintendent, works manager, assistant to the president, director, vice president and treasurer. He is a 1910 graduate of Sheffield Scientific School of Yale University, and began his business career as an apprentice tool maker at the Geometric Tool Company, New Haven, Connecticut. Later, he was assistant superintendent of the National Blank Book Company, Holyoke, Massachusetts.

J. C. Merwin

G. M. Dyke, assistant treasurer, was named treasurer; A. F. Kessler, also an assistant treasurer, was named to the new office of comptroller, and Walter Kasten, president of the First Wiscon-

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sin National Bank, Milwaukee, was made a director. Both Dyke and Kessler joined the company in 1923. When the company acquired Stearn Conveyor Company, Cleveland, in 1926, Dyke was elected vice president of the subsidiary, but returned to Milwaukee in 1933 when operations of the conveyor plant were moved there. Kessler was chief accountant before becoming assistant treasurer in 1938.

H. N. McClatchey, formerly with Parkersburg Rig & Reel Company, has joined the Mid-Continent sales staff of Butler Manufacturing Company, Kansas City. Active in oil production sales work since 1928, he will make his headquarters in New Iberia, Louisiana. Ralph Downes is field supervisor.

H. N. McClatchey

W. F. Rockwell, Jr., vice president of Pittsburgh Equitable Meter Company, is representing his company on an "industrial exploration tour" of six South American countries, which started March 17 and is scheduled to extend to April 30 and arranged by the National Research Council in cooperation with the Inter-American Development Commission. The party will tour Colombia, Peru, Chile, Argentina, Uruguay and Brazil, and on its return will submit a report on industrialization possibilities to the Department of Commerce, the Inter-American Development Commission and other interested government departments and agencies.

W. F. Rockwell, Jr.

Lee H. Hill, who has been head of the transformer department of Allis-Chalmers Manufacturing Company since 1936, has been named assistant manager of the company's electrical department and given general supervision of the department's sales promotional activities. He served two years as instructor in electrical engineering at Cornell University immediately following his graduation from that institution; became associated with Westinghouse Electric & Manufacturing Company as transformer design engineer and as engineer in charge of power transformer development. For several years he was manager of the transformer division of American Brown Boveri Company, joining Allis-Chalmers Manufacturing Company in 1931 when it absorbed the former company.

Lee H. Hill

G. D. Groce, who has been connected with the automotive industry in a manufacturing and engineering capacity for many years, and for the past 10 years service manager for Cleveland Tractor Company, last week was named general service manager for The Buda Company. He will make his headquarters at the company's general offices at Harvey, Illinois.

G. D. Groce

Harry J. Scheidt, graduate of Brooklyn Polytechnic Institute, has joined the engineering department of Northern Equipment Company. On completing a factory training course, he will be assigned to duty as a service engineer.

W. W. Tomes has been appointed head of the flow meter section of Cochrane Corporation. A 1928 graduate of Purdue University, he has been associated with Firestone Tire & Rubber Company in flow measurement and steam distribution work and, more recently, in meter field engineering and sales work. He will be assisted by W. C. Morrison, formerly with Brooklyn Union Gas Company as a sales engineer. Morrison attended the University of

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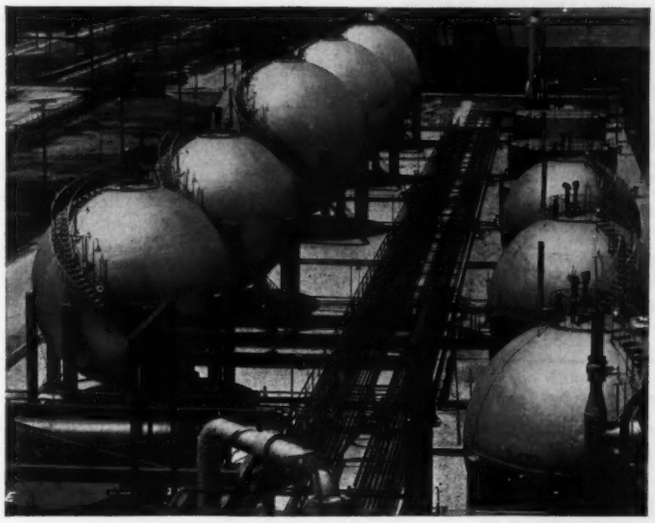

The picture shows a group of Hortonspheres at Pt. Arthur, Texas. In use by Gulf Oil Company for butane storage.

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Pictured is the new plant and office of United Valve Repair Company at 116 Delano Street, Houston. Machinery has been installed to renew and rebuild worn or defective valves, gauges and slips used in the refinery, drilling, producing and pipe line branches of the industry. Cal E. Hodges and Melvin Collins are principals of the company.

North Carolina, and graduated from Brooklyn Polytechnic Institute in 1936.

L. A. Estes has been elected president of South Chester Tube Company, succeeding the late Gustavus W. Cook. Estes was formerly executive vice president. John W. Lawton, continuing as secretary, has also been elected Treasurer, succeeding Francis J. Tucker, who is joining the sales department as special representative.

Charles H. Hoefer has been made general superintendent of The Duraloy Company, Scottdale, Pennsylvania. He was formerly superintendent of the Alloy Division, Lebanon Steel Foundry, and also superintendent of The Forging and Casting Corporation Division of Allegheny Ludlum Steel Company, and Empire Steel Castings, Inc.

E. B. Nisbit, purchasing agent and treasurer of Laminated Shim Company, has been named executive vice president of the company. Other Official changes include E. R. Young, former factory manager, named vice president in charge of production, and Richard Seipt, sales manager, named vice president in charge of sales.

Paul Helms has been named purchasing agent for Roller-Smith Company, succeeding Harry A. Cassler, who resigned. Helms joined the company in 1926 as an inspector. He was transferred to the production department a year later, remaining until appointment as assistant production manager in 1930. He was placed in charge of stores in 1931, later became assistant to the plant manager, and was named assistant purchasing agent in 1939.

Eric R. Woodward, formerly associated with Barrett Company, has joined the sales development department of The Mathieson Alkali Works, 60 East 42 Street, New York, where he is engaged in promotional work on new products. For several years he has specialized in industrial sales work in both the heavy chemical industry and the petroleum industry, traveling extensively throughout the United States, Canada and Europe.

William W. Britton has been named special representative in the Pacific Coast territory for Jessop Steel Company, with headquarters in the Chamber of Commerce Building, Los Angeles. He has been a member of the company's sales staff for many years, and before his transfer to the Pacific Coast represented the company in the southern territory, with headquarters in Dayton, Ohio.

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